DEVELOPMENT OF AVAILABLE PHOSPHORUS TESTING TOOLKIT FOR FARMERS

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INTRODUCTION

Knowing the level of phosphorus (P) in cropping fields is very important to manage the P level in the soil. Soil test is an important tool of P management for crops. Soil testing provides the soil P level, and helps to determine the optimum amount of P fertilizers required for the crop to be grown. Soil analytical laboratories of the Department of Agriculture (DOA) in Sri Lanka provide the service of soil testing. But this has not been convenient for farmers as they have to travel a long distance to handover the soil samples to the nearest DOA and pay for it. Most of the time the farmers do not get the results of the soil samples before cultivation. Usually the farmers do not tend to do a soil test before cultivation because of those reasons. If there is a rapid and easy method for testing P level in the soil by farmers themselves or with the help of Agricultural Instructors in their area, management of P levels in cropping will be more effective and efficient. Simple and rapid methods of testing have several benefits such as minimizing the time taken for the recommendation, and the need for skills, equipments and chemicals which are used for testing P in soil. This may create more benefits, in turn, for farmers through motivating them to do soil testing without waiting for the analytical report and getting the P level in their soil just before the application of phosphorus fertilizer for the cultivation. This will minimize the wastage while increasing the efficacy of phosphate fertilizers. Therefore, this study was undertaken to develop a new, simple soil phosphorus testing tool kit for farmers so that they could do the testing of available phosphorus in their land before each season and decide on the appropriate phosphorus fertilizer level. This will ultimately reduce soil and water pollution due to excess application of phosphorus fertilizer.

MATERIALS AND METHODS

Soil samples received under the soil testing program of the Agricultural Chemistry division at Horticultural Crops Research and Development Institute, Gannoruwa were used for this study. Seventy five samples were randomly selected for the study. To decide the phosphorus fertilizer application the well established Olsen method (Olsen *et al*., 1954) is used to extract the available soil P. Further, the majority of the randomly selected soil samples of this study had a pH in the range of 6.5 to 7.2 which represent the mild acidic to basic soil type and the Olsen method was the most suitable method for such soils (Olsen *et al*., 1954). Extracted P contents in each sample were measured using Murphy and Riley method (1962) which used ammonium vanado molibdate and ascorbic acid as the color development regent.

Development of a new method for measure the soil phosphorus

Available Phosphorous in soils was extracted using four different methods which were different in their extractant; (1) Morgan's method (0.72 N Sodium Acetate + 0.52 N Acetic Acid solution), (2) Basified distilled water method (Distilled water basified using NaOH and pH adjusted to 8.5), (3) Distilled water only method (pH 4.8), (4) Acetic Acid method (2.5% acetic acid solution). The selected 75 soil samples were used to measure and compare the

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amounts of phosphorus extracted by 4 different extraction methods. For each method, 5 g of air-dried, sieved soil and in order to get colour less filtrate, pinch of (01 -0.2 g) P free charcoal were mixed with 50 ml of each extraction solution in a dry and clean plastic bottle. The solution was mixed with hand shaking upside down for 2 minutes and filtered using No. 5 Whatman filter paper. The extracted soil phosphorus was measured by using "Murphy and Riley colorimetric method" (Murphy et al., 1962). Acetic acid extraction method was further simplified as it has given higher r^2 value with Olsen's method at the results comparison stage. The selected 75 soil samples were used for this method also. Five grams of soil sample and 50 ml of 2.5% acetic acid solution were mixed for 2 minutes with hand, kept it about 3 hours until the supernatant separate. The supernatant was analyzed for phosphorus using "Murphy and Riley colorimetric method" (1962). In this method neither phosphorus free charcoal added nor filter paper used to separate the solution from soil.

RESULTS AND DISCUSSION

Identification of best extraction method

The soil phosphorus contents extracted using the four different extraction methods were measured using the Murphy and Riley colorimetric method and the results were correlated with the Olsen method. The correlations were taken from the Regression analysis.

Among the five new soil P extraction methods the simplified acetic acid method is the simplest method and has the highest correlation (r^2) with the recommended phosphorus extraction method which is the Olsen. The simplify acetic acid method was selected as the simplest method which can be applied for phosphorus test in field level. Simplify acetic acid method was differed from the acetic acid method due to not adding P free charcoal. The extractant used in both methods was same and it gave clear supernatant after 3 hours and supernatant could be separated without using the filtrate. Due to this the step of adding P free charcoal, to get colorless solution, was removed in simplified acetic acid method. The R-square between acetic acid method and simplify acetic acid method was 0.976. It shows there is no significant difference in added P free charcoal or not.

Table 1. Correlation of new extraction methods with Olsen's method

Method	Correlation with Olsen method (R^2)
Mogan's method	0.734
Basify distilled water method	0.654
Distilled water method	0.585
Acetic acid method	0.854
Simplify Acetic acid method	0.855

Development of Phosphorus color chart

A color chart was prepared to measure the phosphorus level in the extraction solution. "Murphy and Riley" colorimetric method was used to prepare the color chart. It is a colorimetric method and forms a blue color of which the intensity depends on the concentration of P. The R-square of Olsen's method and simplify Acetic acid method was 0.855 and linear of regression graph was $y = 0.548x - 5.728$. P content of low phosphorus soil, medium phosphorus soil and high P soil according to the simplify acetic acid method were calculated using this equation (Table 2). Accordingly the low P soil content <2.5 mg/L P, medium P soil content between 6.6 – 10.7 mg/L P and high P soil content > 10.7 mg/L P. These values were used to prepare the color chart (Figure 1).

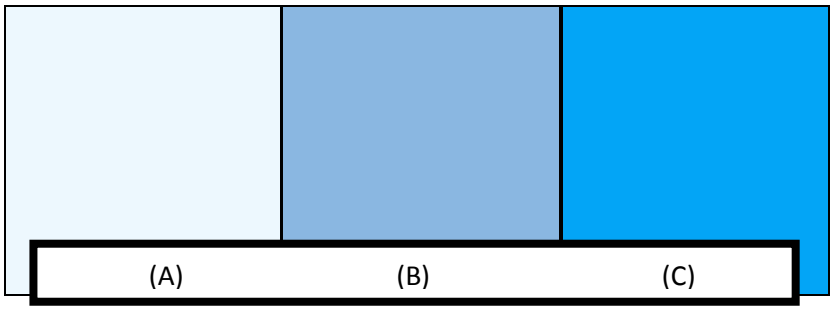
The blue color intensities of 10.7 ppm, 6.6 ppm and 2.5 ppm soil solutions were prepared using P standards of the "Murphy and Riley" colorimetric method and these colors were

captured by camera and these colors were used to prepare the Phosphorus color chart. The color chart consists of 3 different intensities of blue; (A) color shows the blue color intensity of 2.5 mg/L available P extraction, hence it represents the soil which has 2.5 ppm available P soil, (B) color shows the color intensity of 6.6 mg/L available P extraction and (C) color shows the color intensity of 10.7 mg/L available P extraction represent the 6.6 ppm and 10.7 ppm p soil respectively (Table 2).

A color developed sample's phosphorus level can be determined using this color chart. If the blue color intensity of prepared sample is lower than the color "A" it is a low phosphorus soil, the color intensity between "A" and "B" color it is a medium phosphorus soil, the color intensity is between "B" and "C" color it is a high phosphorus soil and higher than "C" color it is extremely high phosphorus soil.

Table 2. Phosphorus content of soil extracted by simplify acetic acid method

	Available P (ppm) according to the simplify acetic acid method	**Available P (ppm) according to the Olsen method**
Extremely high	>10.7	>30
High	6.6 - 10.7	22.5 – 30
Medium	2.5 - 6.6	15 - 22.5
Low	<2.5	<15



Color	**P content**
>C	Extremely high P soil
B - C	High P soil
A - B	Medium P soil
< A	Low P soil

Figure 1. Phosphorus color chart developed and the ranges of P content

Development of soil phosphorus testing tool kit for farmers

This tool kit was developed based on the findings of this study (Figure 2). The new soil available phosphorus test can be applied in the field with this tool kit. The tool kit includes distilled water, 2.5% acetic acid solution, mixed regent, ascorbic acid, a clean glass bottles, the soil P color chart (which has drastic colour differences between classes, so that fairly stable for different sunlight intensities) and also the note of the procedure of new phosphorus testing method. This tool kit is very easy to transport and handle and does not cost more than Rs 200. However, these kits could be given to farmers free of charge or at an affordable price. Soil P can be measured according to the procedure introduced by this study by using this tool kit by the farmers themselves and decide the phosphate fertilizer application.

To get the accurate level of phosphorus, soil sample should consist of fine particles and it should be dry. Wet soil samples can be used to test for phosphorus after allowing them to dry).

Recommended P fertilizer should be applied to the low P soil before the cultivation. There is no need of P fertilizer application to the high or extremely high P soils before the cultivation.

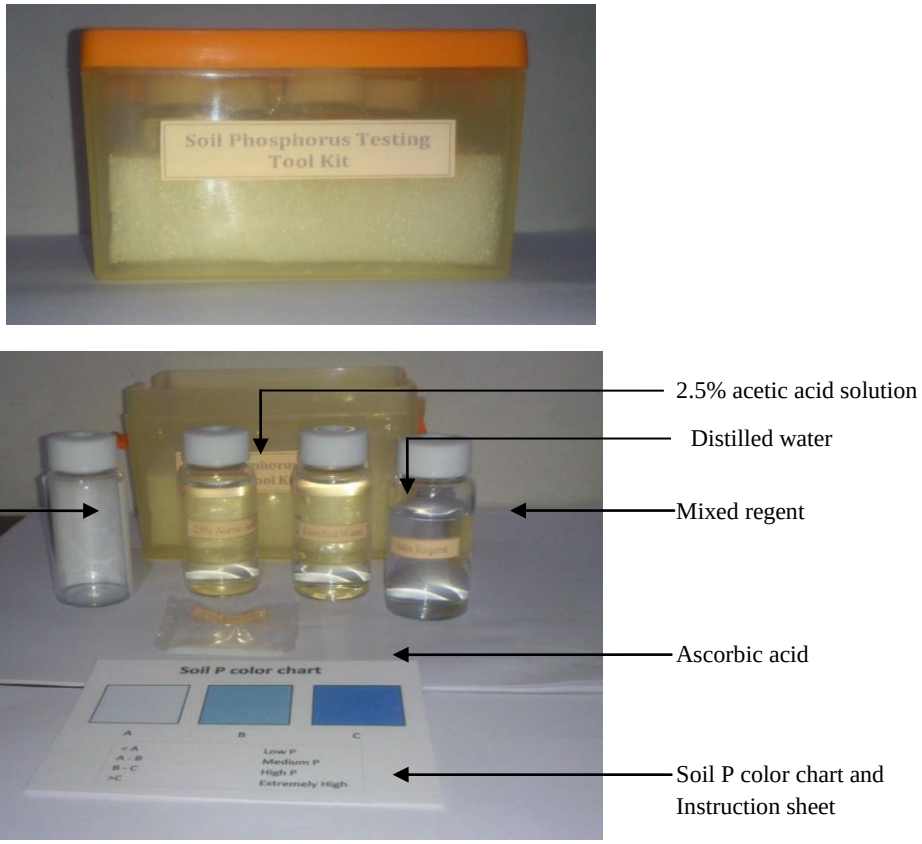


Figure 2. Phosphorus testing tool kit for farmers

CONCLUSION

The simplified acetic acid method which has the best significant correlation with the Olsen method can be introduced to determine the available soil phosphorus. This method is quick, simple and time saving. Measuring of extracted phosphorus is very easy. The introduced phosphorus color chart can be handled easily to measure the extracted phosphorus level, after developing the blue color of the extracted solution. Therefore even farmers can apply this quick method to measure the soil phosphorus in the cultivation lands before the cultivation.

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