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STUDY OF INSTRUMENTAL VARIATIONS ON THE COLORIMETRIC ESTIMATION OF AVAILABLE PHOSPHORUS IN SOILS*

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Introduction

A number of colorimeter models have been introduced to the market of late, by foreign as well as Indian firms and one or other is in operation by various centres of soil research in this country. No information whatsoever is available regarding the variations caused by the use of different instruments in a particular analytical estimation. In the present study, available soil-phosphorus was measured simultaneously by three models of colorimeters namely, Klett Summerson, (USA) Systronix (India) and Spectronic 20, USA manufactured by Klett Manufacturing Co., Inc., New York; Systronix, Naroda, Ahmedabad and Baush and Lomb, Rochester, New York, respectively in order to assess the degree and extent of instrumental variations, if any.

Materials and Methods

A total number of thirty soil samples having a wide range of available P_2O_5 contents were extracted by Bray and Kurtz (1) extractant No. 1. The phospho-molybdenum blue colour developed in HCl system from an aliquot of the soil-extract of each sample was read side by side with Klett, Systronix and Spectronic 20, using filter number 66 (approx. 640–700 mμ), filter number 608 (630mμ and above) and 660 mμ respectively, within a period of half an hour from the time of colour development. The P_2O_5 content of the soils were calculated from previously drawn standard curves for the respective instruments. Variations in the phosphorus content for the present set of soils attributed by the instrumental differences were worked out by employing paired 't' test. Subsequently, one to one correspondence method was employed to predict observation that would be recorded by the other instrument, if the observed values of one was known. Comparisons were made between the pairs of colorimeters viz., Klett vs Systronix, Systronix vs Spectronic 20 and Klett vs Spectronic 20 and their 't' values were tested.

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Results and Discussion

The 't' values calculated for pairs of colorimeters are given in Table 1 along with their confidence limits of difference at 95 and 99 per cent levels of probability.

Table 1 – Variations in the phosphorus content in soil samples estimated by three different colorimeters — 't' values

Interactions	't' value	Mean of difference	S.E. mean of difference	Confidence limits of difference			
				95%		99%	
Klett vs Systronix	2.734*	+5.56	2.032	+5.56	±21.91	+5.56	±26.48
Systronix vs Spectronic 20	2.344*	—5.54	2.364	—5.54	±25.40	—5.54	±25.46
Klett vs Spectronic 20	0.011	...	...	...	...	...	...

* Significant at 5% level

An examination of the data shows that P_2O_5 values differ significantly when measured by Klett and Systronix, Systronix and Spectronic 20 and no such difference exists between Klett and Spectronic 20. This means that, if a set of samples are measured for their P_2O_5 content separately by Klett and Spectronic 20, the results obtained under each instrument would have more or less identical values. The difference of means (Table 1) between Klett vs Systronix, Systronix vs Spectronic 20 are in the order of + 5.5 and — 5.5 respectively suggesting that P_2O_5 values when measured by Systronix colorimeter are less by 5.5 ppm when compared with the values obtained by the remaining two instruments. Although the reason for such difference is difficult to pinpoint, the use of filter having a broad band of wavelength might be one of the factors. Out of hundred, ninety-nine observations would have their variations due to Klett vs Systronix and Systronix vs Spectronic 20 between + 5.56 + 28.48 and — 5.54 + 25.46 respectively.

Attempts were made to establish a relation between a set of two colorimeters so that by knowing an observed value of one, the calculated value of the other could be worked out. For this purpose, value of those colorimeters which differed significantly were taken and regression lines were drawn between two

sets of observations recorded by two colorimeters with the help of least square method. Subsequently, the regression co-efficients were tested and were found to be highly significant. The regression equations for each pair of colorimeter along with the standard deviation of the estimated value are given below.

i) *Klett vs Systronix:*

If the available P_2O_5 content of soils measured with Klett is denoted by X and that of Systronix by Y, then, Y value could be obtained from the equation,

$$Y = -3.57 + 0.978 \times \ldots\ldots\ldots\ldots (1),$$

when × is known. Simiarly, × value could be obtained from the equation.

$$X = +4.63 + 1.011\ Y \ldots\ldots\ldots\ldots (2),$$

when Y is known. Therefore, for $X (=x_1)$, the standard deviation of $\hat{Y}$ is =

$$Sy = \sqrt{[120.73 + 0.0111\ (x_1 - 90.50)^2]} \ldots\ldots\ldots (3),$$

when x_1 is any observation measured by Klett and $\hat{Y}$ is the estimated value of Y. So also for given $Y (=y_1)$, the standard deviation of $\hat{X}$ is

$$Sx = \sqrt{[116.04 + 0.011\ (y_1 - 84.94)^2]} \ldots\ldots\ldots (4),$$

where y_1 is any observation measured by Systronix colorimeter and $\hat{X}$ is the estimated value of X.

ii) *Systronix vs Spectronic 20:*

Let P_2O_5 contents of soils recorded by Systronix and Spectronic 20 be designated by M and N respectively. Then, N value could be obtained from the regression equation $N = -.0\ 83 + 1.075\ M \ldots\ldots\ldots (5)$, when M is known.

So also,

$$M = 1.52 + 0.922\ N \ldots\ldots\ldots\ldots (6),$$

when N is known. The standard deviation for $\hat{N}$ is

$$Sn = \sqrt{[106.65 + 0\ 0101\ (m_1 - 84.94)^2]} \ldots\ldots\ldots (7)$$

where, $M (= m_1)$ is any observation.

Similarly, that for $\hat{M}$ is

$$Sm = \sqrt{[89.25 + 0.0073\ (n_1 - 90.48)^2]} \ldots\ldots\ldots (8)$$

where $N (= n_1)$ is any observation.

By selecting a suitable regression equation, from an observed value of one instrument, the corresponding value with the other could be predicted. An example of this type for a set of five observed values selected at random out of thirty observations has been included in Table 2 for the clarity of understanding with all possible combinations between the colorimeters under study.

Summary

Available phosphorus content of thirty soil samples were estimated by three colorimeters under identical conditions and found that the values recorded by Klett-Summerson vs Systronix, Systronix vs Spectronic 20 vary significantly. There was no variation in P_2O_5 content of soils when measured by Klett and Spectronic 20. In general, available soil P_2O_5 values obtained from Systronix were lower by 5.5 ppm when compared with the values of Spectronic 20 and Klett-Summerson colorimeters. Regression equations were worked out to predict the value that would be measured by another instrument, if the observed value of one was known.

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Literature Cited

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Table 2 – Observed and calculated values of soil P_2O_5 as measured by three different photoelectric colorimeters

	P_2O_5 in ppm											
No.	Klett observed X	Systronix calculated $\hat{Y}$	S.D.† Sy	Systronix observed Y	Klett calculated $\hat{X}$	S.D.† Sx	Systronix observed M	Spectronic 20 calculated $\hat{N}$	S.D.† Sn	Spectronic 20 observed N	Systronix calculated $\hat{M}$	S.D.† Sm
1	323.4	312.7	±26.88	296.4	304.3	±24.65	296.4	317.8	±23.62	342.6	317.4	±23.52
2	178.2	170.7	±14.36	159.6	166.0	±13.32	159.6	170.7	±12.76	184.8	171.9	±12.42
3	127.8	121.4	±11.67	117.6	123.5	±11.30	117.6	125.6	±10 84	127.2	118.8	± 9.95
4	55.2	50.5	±11.60	43.2	48.3	±11.63	43 2	45.6	±11.15	52.8	50.2	± 9.98
5	16.8	12.8	±13.45	14.4	19.2	±13.07	14.4	14.7	±14.7	18.0	11.5	±11.29

† S.D. = Standard deviation of the calculated values for a given set of observed values