Effect of temperature on the determination of available phosphorus in soil in northern China

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Abstract. The determination results of soil available phosphorus at different temperatures are greatly affected, in order to study the correlation between temperature and soil available phosphorus and the correlation coefficient. In this experiment, according to the determination method of available phosphorus in neutral and calcareous soil, the effect of different color rendering temperature on available phosphorus content in alkaline soil in northern China was studied. The results show that when the available P is measured, the suitable color temperature is 25~30°C; At 25°C as the standard, the soil available P values reached a very significant positive correlation at different temperatures, and the correlation coefficients were 0.983**, 0.991**, 0.996** and 0.988**, respectively.

1. Introduction
The determination of soil available phosphorus can enable us to understand the current status of soil phosphorus supply, and has important guiding and reference values for diagnosing soil fertility, rational fertilization, increasing yield and protecting the environment [1]. Shaanxi soil belongs to alkaline and calcine soil, which is suitable for the Olsen method (0.5mol/L NaHCO₃) for the determination of available phosphorus [2-3]. The Olsen method is used for the measurement of available phosphorus in alkaline soil in Shaanxi, and there are few studies on the effect of color temperature on available phosphorus. In accordance with the Olsen method for the determination of available phosphorus in neutral and calcine soils, this paper analyzes the effect of color temperature on the available phosphorus content in alkaline soils in Shaanxi, northern China, and improves the accuracy of the determination results, so as to provide a certain reference for the determination of available phosphorus content in soil in northern China and the formulation of fertilization.
2. Materials and methods

2.1. Test materials
In this experiment, the national standard soil samples GBW07460 (ASA-9) Shaanxi yellow miansoil with a pH value of 8.50, GBW07461 (ASA-10) Anhui moist soil with a pH value of 8.18 were used, as well as 6 soil samples from the land development project in Fulinpu section of Xiguan sub-district office, Jintai district, Baoji city. TU-1810 uv-visible spectrophotometer was used to measure the absorbance at the wavelength of 880nm. ZD-85 constant temperature oscillator, temperature control range: room temperature ~50°C, oscillation frequency: 0~300 r·min⁻¹.

2.2. Experiment design and methods
This experiment is based on the determination method of available phosphorus in neutral and calcareous soil samples (pH ≥6.5) (NY / T1121.7-2014). Each sample is tested in triplicate. All conditions are the same during the experiment. The only difference is that after adding molybdenum antimony mixed developer, adjust the temperature of the constant temperature oscillator to 10 °C, 15°C, 20°C, 25°C, 30°C, and use a 1cm light diameter cuvette after 30min. The spectrophotometer performs colorimetry at a wavelength of 880 nm, measures the absorbance value of the sample, and finally calculates the effective phosphorus content and absorbance value based on the absorbance value.

3. Results and analysis
Accurate determination of available phosphorus content in soil enables us to understand the current status of phosphorus supply in soil, which is the most basic and critical link in soil testing, formulation fertilization and soil fertility diagnosis, and has important guiding significance for ensuring high yield, high quality and efficient precise application of fertilizer to crops [4]. Since the temperature coefficient of the measured value of available phosphorus by Olsen method is relatively large, remedial measures need to be taken in laboratories with large seasonal indoor temperature differences in northern China [5]. In this paper, the determination of available p in alkaline soil in Shaanxi of north China at different color temperature was designed.

According to the climatic conditions and crop layout in Shaanxi, the color temperature was controlled by an incubator, and the available phosphorus in the tested soil was measured at five temperature levels of 10°C, 15°C, 20°C, 25°C, and 30°C. It can be seen from the measurement results (table 1) that with the increase of color temperature, the available p content of the eight test soils also increased. At 25°C, the available p content of 8 test soils was 2.7~26.0mg/kg, with an average value of 8.5mg/kg. With 25°C as the standard, the extraction temperature of 10°C decreased the content of available phosphorus by 0.9~4.9mg/kg, 0.7~3.4mg/kg decreased by 15°C compared with 25°C, 0.5~2.1mg/kg decreased by 20°C compared with 25°C, and 0~0.4mg/kg increased by 30°C compared with 25°C.

| Sample number | 10°C  | 15°C  | 20°C  | 25°C  | 30°C  | Standard values |
|---------------|-------|-------|-------|-------|-------|----------------|
| ASA-9         | 21.1  | 22.6  | 23.9  | 26.0  | 26.4  | 21~27          |
| ASA-10        | 9.4   | 10.1  | 10.6  | 12.1  | 12.5  | 9.6~12.8       |
| 1             | 5.7   | 6.3   | 6.9   | 7.8   | 8.2   | /              |
| 2             | 3.2   | 3.5   | 3.7   | 4.3   | 4.4   | /              |
| 3             | 1.8   | 2.0   | 2.2   | 2.7   | 2.7   | /              |
| 4             | 3.1   | 3.4   | 3.7   | 4.5   | 4.7   | /              |
| 5             | 3.3   | 3.7   | 4     | 4.8   | 4.9   | /              |
| 6             | 4.2   | 4.7   | 5.2   | 5.9   | 6.1   | /              |

With 25°C as the reference, with the increase of the extraction temperature, the difference between the available phosphorus content and the temperature at 25 °C decreased, and the difference between the effective phosphorus content between the temperatures also decreased. The amount of phosphorus
is also different due to the effect of extraction temperature on soil available phosphorus. The available p content increased significantly at the color developing temperature of 20°C~25°C, and increased slowly at the color developing temperature of 10°C~20°C and 25°C~30°C. The available p content reached the highest at the temperature of 30°C. There was a difference in the available p content of the tested soil when the color developing temperature was 25°C and 30°C, but the difference was not significant, which was within the allowed error range. However, the available p content value was relatively low when the temperature was 10°C, 15°C and 20°C, and the difference was large, which was beyond the allowed error range. This may be due to the above three temperature didn't reach full color, so that there are no detected the maximum effective phosphorus content in soil, and 10°C when GBW07461 (ASA - 10) effective phosphorus content is lower than the standard range, if this result as to understand the current ability of the supply of available p in soil, to guide agricultural production, waste not only can cause excessive phosphate fertilization, fertilizer, but also increase my cost. Moreover, the available p content of soil at 10°C, 15°C and 20°C is significantly different from that at 25°C and 30°C, reaching an extremely significant level. Therefore, it is proved that the effect of extraction temperature on the determination results of soil available p is significant. Through the above experiments and analysis, it is concluded that the appropriate color temperature should be controlled at 25°C~30°C for the determination of soil available phosphorus.

Table 2 shows the correlation between the measured values of soil available phosphorus at different temperatures, and the results all reach a very significant level of positive correlation. With 25°C as the standard, the correlation coefficients of soil available phosphorus measured at 10°C, 15°C, 20°C and 30°C were 0.988**, 0.983**, 0.991** and 0.996**, respectively.

| temperatures | 10°C | 15°C | 20°C | 30°C |
|--------------|-----|-----|-----|-----|
| 25°C         | 0.988** | 0.983** | 0.991** | 0.996** |

4. Conclusion

Olsen method can be better applied to calcareous soil. Compared with acidic and neutral soil, Olsen method on alkaline soil the correlation between available phosphorus is more significant [6]. In this paper, Olsen method was used to study the effect of different color temperature on available p content in alkaline soil in Shaanxi, north China. The results showed that the extraction temperature was a very important factor in the experiment of determining available p content in soil by Olsen method, which had a great influence on the determination results. This test proved that within 10 to 30°C with the increase of temperature, the effective phosphorus content of the tested soil increases, the color temperature at 25°C ~ 30°C the effective phosphorus content of the tested soil within the allowed error range, and because of the different vibrations of soil phosphorus content of available p in soil influence degree also has difference, the temperature of effective phosphorus were very significant positive correlation between the measured value. Therefore, when Olsen method is used to measure soil available phosphorus, a temperature control device should be equipped to control the extraction temperature. The appropriate color developing temperature should be controlled at 25±1°C, and temperature correction should be made when necessary.

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