Introduction

The Tibetan Plateau is the third-largest glaciated area of the world and is one of the most sensitive regions due to climate warming, such as fast-melting permafrost, dust blow and overgrazing in recent decades. Climate warming and land-use change can reduce soil organic carbon (SOC) stocks as well as soil nitrogen (N) and phosphorus (P) contents and soil quality. Many species showed their distributions by climate-driven shifts towards higher elevation. In Tibetan Plateau, however, the elevational variations of the alpine grassland are rare and it is largely unknown how the grass line will respond to global warming and whether soils play a major role. With this research, the hypothesis would be tested that soil quality, given by SOC, N and P stocks and content, is a driving factor for the position and structure of the grass line and that soil quality is one of the major controls of biodiversity and biomass production in high-mountain grassland ecosystems. A Fourier transformation near and mid-infrared spectroscopy (FT-NMIRS) should be used to measure soil P fractions and for large numbers of soil samples, and analyze environmental factors, including temperature, precipitation, soil development, soil fertility, and the ability of plants to adapt to the environmental impact of climate using FT-NMIRS. We explored first near-infrared spectroscopy (NIRS) in soils from grassland on the Tibetan Plateau, northwestern China and extracted P fractions of 196 samples from Haibei Alpine Meadow Ecosystem Research Station, Chinese Academy of Sciences, at four depths increments (5-10 cm 10-20 cm 20-40 cm and 40-70 cm) with different pre-nutrient additions of N and P (Table 1). The fractionation data were correlated with the corresponding NIRS soil spectra and showed significant differences for depth increments and fertilizer amendments. The r² of NIRS calibrations to predict P in traditional Hedley fractions (Table 2) ranged between 0.12 and 0.90.

Material & Methods

• Soil samples

Table 1. Nutrient addition to grassland soils experiment by CAS (N: nitrogen, P: phosphorous).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Fertilizer</th>
<th>Amount (the &quot;R&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Triple Superphosphate (TSP)</td>
<td>50 kg</td>
</tr>
<tr>
<td>N</td>
<td>Carbamid CO(NH₂)₂</td>
<td>50 kg P+100 kg N</td>
</tr>
<tr>
<td>N2S</td>
<td>Carbamid CO(NH₂)₂</td>
<td>25 kg</td>
</tr>
<tr>
<td>N50</td>
<td>Carbamid CO(NH₂)₂</td>
<td>50 kg</td>
</tr>
<tr>
<td>N100</td>
<td>Carbamid CO(NH₂)₂</td>
<td>100 kg</td>
</tr>
<tr>
<td>Control</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

• Hedley Fractionation

Table 2. The Hedley fractionation steps according to published theory and assignment of Hedley P fractions to soil P pools

Results

Figure 1. Mean proportions of Hedley P fractions for different nutrient amendment

• The total P values of all Hedley fractions covered a wide range from 0 to 503 µg g⁻¹ soil. For each depth increment and amendment, the labile P fractions (Resin –P and NaHCO₃-P) and moderately labile (NaOH -P) showed comparably lower values. Labile P and moderate P showed the same proportion of about 3-4% of total P and Stable P covered about 65% (Figure 1).

• For the NIRS models, both r² and r² values are higher for cross validation than for external validation for all seven Hedley fractions (Table 3) and the applicability of the NIRS models based on the r² values according to published results are given. For the majority of the fractions, the moderate P pool and stable P pool, the NIRS model could predict well.

Conclusion & Outlook

• The fractionation data were correlated with the corresponding NIRS soil spectra and showed significant differences for depth increments and fertilizer amendments as well as the NIRS model prediction quality, which was higher for organic than for inorganic P fractions.

• The results indicate that using NIRS to predict the P fractions can be a promising approach compared with traditional Hedley fractionation for soils in alpine grasslands on the Tibetan Plateau.

• However, for some P fractions, especially the labile P pool, the calibration results were not precise enough to be used due to the limited number of samples.

• The NIRS model, as well as the MIRS model based on larger soil sampling number will be built to predict relevant soil physical and chemical properties.

References


