Data Article

Data on soil properties and halophilic bacterial densities in the Na Si Nuan Secondary Forest at Kantharawichai District, Maha Sarakham, Thailand

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ABSTRACT

Saline soil is one of the most crucial problems of arid and semi-arid regions because it reduces growth of plant and microorganisms. In Thailand, the inland saline soils are found mostly in the northeastern part especially in Maha Sarakham Province where 85% of the province has geological characteristics as rock salt beds. Saline soil often experiences low soil fertility problems which multiply the adverse effects on plant growth. Interestingly, the Na Si Nuan Secondary Forest, Kantharawichai District, Maha Sarakham, is not affected by salinity although almost the entire province of Maha Sarakham is salt-affected area. Saline soil is a habitat of halophilic bacteria. Bacteria are the most important microorganisms contribute to soil fertility and soil health. Thus data regarding the density of culturable halophilic bacteria and soil properties in this forest soil is useful for reclamation of saline soil and helping to sustain the forest ecosystem.

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1. Data

The data are from the 14-sampling plots investigating the seasonal dynamics of main physical and chemical soil properties and the density of non-, slightly-, and moderately halophilic bacteria. Main physical and chemical properties of soil collected in three seasons (hot, rainy and cool) from Na Si Nuan Secondary Forest, Kantharawichai District, Maha Sarakham Province, Thailand, are summarized in Tables 1 and 2. The status of soil properties were assessed against the criteria from Land Classification Division and FAO Project Staff [1], Landon [2], and Soil Survey Division Staff [3] (Table 3).

Table 1
The pH, electrical conductivity (EC), and soil texture class of soil samples collected from Na Si Nuan Secondary Forest, Maha Sarakham, among the three seasons.

| Sampling plot | pH (1:1 H2O) | EC (1:5) (dSm⁻¹) | Soil texture |
|---------------|--------------|------------------|--------------|
|               | Hot          | Rainy            | Cool         | Hot          | Rainy            | Cool         |
| 1             | 4.8          | 4.7              | 5.9          | 0.12         | 0.08             | 0.04         | Sandy loam   | Loamy sand   | Sandy loam   |
| 2             | 5.4          | 5.5              | 6.3          | 0.11         | 0.10             | 0.05         | Sandy loam   | Loamy sand   | Loamy sand   |
| 3             | 4.7          | 4.7              | 5             | 0.09         | 0.02             | 0.02         | Loamy sand   | Loamy sand   | Sandy loam   |
| 4             | 4.7          | 4.1              | 4.9          | 0.04         | 0.08             | 0.01         | Loamy sand   | Sandy loam   | Sandy loam   |
| 5             | 4.4          | 4.0              | 4.6          | 0.02         | 0.06             | 0.02         | Sandy loam   | Loamy sand   | Loamy sand   |
| 6             | 4.2          | 3.8              | 4.9          | 0.06         | 0.07             | 0.01         | Loamy sand   | Loamy sand   | Sandy loam   |
| 7             | 3.9          | 3.9              | 4.6          | 0.07         | 0.10             | 0.03         | Loamy sand   | Loamy sand   | Loamy sand   |
| 8             | 4.0          | 3.8              | 4.9          | 0.08         | 0.08             | 0.02         | Sandy loam   | Loamy sand   | Loamy sand   |
| 9             | 3.9          | 4.1              | 4.8          | 0.06         | 0.06             | 0.02         | Sandy loam   | Loamy sand   | Sandy loam   |
| 10            | 4.1          | 3.8              | 5.0          | 0.08         | 0.08             | 0.02         | Sandy loam   | Loamy sand   | Sandy loam   |
| 11            | 4.2          | 4.1              | 4.8          | 0.06         | 0.09             | 0.04         | Loamy sand   | Sandy loam   | Sandy loam   |
| 12            | 4.2          | 4.0              | 5.0          | 0.13         | 0.08             | 0.01         | Sandy loam   | Sandy loam   | Loamy sand   |
| 13            | 4.3          | 4.1              | 5.4          | 0.07         | 0.06             | 0.02         | Loamy sand   | Sandy loam   | Loamy sand   |
| 14            | 4.3          | 4.2              | 6.0          | 0.08         | 0.09             | 0.04         | Loamy sand   | Sandy loam   | Loamy sand   |
| Max.          | 5.7          | 5.5              | 6.3          | 0.13         | 0.10             | 0.05         |              |              |              |
| Min.          | 3.9          | 3.8              | 4.6          | 0.02         | 0.02             | 0.01         |              |              |              |
| Ave.          | 4.4          | 4.2              | 5.2          | 0.08         | 0.08             | 0.03         |              |              |              |
The density of non-, slightly-, and moderately halophilic bacteria of soil collected in three seasons from the study site are summarized in Table 4. The fifty-six bacterial isolates were obtained through bacterial enumeration processes. From an initial observation of the Gram stain status and morphological features of the bacterial isolates using a light microscope, most of them were Gram-positive endospore-forming rods. A one-way ANOVA was used to analyze the difference of soil properties and halophilic bacterial density among the three seasons (Table 5).

2. Experimental design, materials and methods

2.1. Description of sampling area

The sampling area, Na Si Nuan Secondary Forest at Maha Sarakham Province, Thailand, is situated between latitude 16°20’N and longitude 103°12’E with a total area of approximately 19.2 ha. The sampling sites were divided into 14 plots (Fig. 1).

2.2. Sample collection and analytical procedures

Soil samples were collected seasonally during June 2017 to March 2018. The samples were randomly taken from three subplots for each sampling site at a depth of 30 cm using a hand auger. Samples from

| Parameter               | Range                  | Average/Interpretation |
|-------------------------|------------------------|------------------------|
| pH                      | 4.2–5.2                | 4.6/Low<sup>a</sup>    |
| Electrical conductivity | 0.03–0.08              | 0.06/Non-saline<sup>b</sup> |
| Soil texture class      | Loamy sand - sandy loam | -/Coarse<sup>c</sup>    |
| Organic matter (%)      | 0.66–1.06              | 0.88/Low<sup>a</sup>    |
| Total nitrogen (%)      | 0.033–0.052            | 0.044/Low<sup>a</sup>    |
| Available phosphorus (mgkg<sup>-1</sup>) | 3.14–4.90 | 4.24/Low<sup>a</sup>    |
| Available potassium (mgkg<sup>-1</sup>) | 32.6–51.1 | 43.7/Low<sup>a</sup>    |

<sup>a</sup> Interpretation of soil properties from Land Classification Division and FAO Project Staff [1].

<sup>b</sup> Interpretation of soil properties from Landon [2].

<sup>c</sup> Interpretation of soil properties from Soil Survey Division Staff [3].

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the same sampling site were mixed thoroughly to obtain the composite sample. Then a portion (one kilogram) of the composite soil samples was collected and stored at 4°C for further examination.

2.2.1. Physical and chemical analysis of soil samples

The pH, electrical conductivity (EC), soil texture class, organic matter, total nitrogen, available phosphorus and available potassium of the soil samples were determined seasonally. Details of the methods of physical and chemical analysis are given elsewhere on Page et al. [4,5] and Division of Soil analysis [6].

2.2.2. Density of culturable halophilic bacteria

The number of non-, slightly-, and moderately halophilic bacteria in soil samples were enumerated using a spread plate technique. The halobacteria medium [7] containing NaCl at 0, 3, and 6% (w/v) were used for enumeration of non-, slightly-, and moderately halophilic bacteria, respectively. The NaCl concentrations used were chosen from the level of salt requirements for the growth of each group of halophilic bacteria [8]. After incubation at 37°C for 2–3 days, the colony forming units (CFU) were counted. Then the density of culturable halophilic bacteria were calculated and reported as log CFU g⁻¹ of dry soil. Different colonies grown on media were selected and purified for further characterization.

| Sampling plot | Non halophilic bacteria | Slightly halophilic bacteria | Moderately halophilic bacteria |
|---------------|-------------------------|-------------------------------|-------------------------------|
|               | Hot | Rainy | Cool | Hot | Rainy | Cool | Hot | Rainy | Cool |
| 1             | 6.72 | 5.70 | 6.16 | 4.91 | 3.94 | 4.44 | 3.97 | 3.23 | 3.69 |
| 2             | 5.78 | 5.32 | 5.91 | 4.81 | 4.15 | 4.59 | 3.94 | 3.11 | 3.72 |
| 3             | 6.78 | 5.53 | 5.53 | 4.66 | 3.96 | 4.26 | 3.96 | 3.36 | 3.76 |
| 4             | 6.70 | 5.30 | 6.44 | 4.21 | 3.26 | 3.85 | 3.89 | 3.26 | 3.56 |
| 5             | 5.98 | 5.28 | 5.74 | 4.28 | 3.18 | 3.71 | 3.63 | 3.40 | 3.64 |
| 6             | 5.54 | 5.15 | 5.35 | 3.95 | 3.33 | 3.63 | 3.60 | 3.38 | 3.53 |
| 7             | 6.45 | 6.02 | 6.22 | 4.25 | 3.27 | 3.97 | 3.78 | 3.52 | 3.32 |
| 8             | 6.83 | 6.19 | 6.75 | 4.51 | 3.11 | 3.91 | 3.89 | 3.57 | 3.57 |
| 9             | 6.88 | 5.71 | 6.65 | 4.08 | 3.38 | 3.69 | 3.50 | 3.30 | 3.30 |
| 10            | 5.92 | 5.50 | 5.70 | 5.52 | 5.09 | 5.52 | 3.82 | 3.18 | 3.75 |
| 11            | 6.87 | 5.83 | 6.82 | 4.58 | 3.98 | 4.45 | 3.83 | 3.39 | 3.39 |
| 12            | 7.04 | 5.75 | 6.47 | 4.27 | 3.86 | 4.29 | 3.88 | 3.29 | 3.72 |
| 13            | 6.45 | 5.66 | 6.20 | 4.83 | 4.14 | 4.53 | 3.85 | 3.20 | 3.50 |
| 14            | 6.26 | 5.28 | 6.18 | 4.80 | 4.03 | 4.66 | 3.85 | 3.23 | 3.73 |

Max. 7.04 6.19 6.82 5.52 5.09 5.52 3.97 3.57 3.76
Min. 5.54 5.15 5.35 3.95 3.11 3.63 3.50 3.11 3.30
Ave. 6.44 5.59 6.15 4.55 3.76 4.25 3.81 3.32 3.60

Table 5: Statistical analysis of soil properties and halophilic bacterial density among the three seasons.

| Parameters | Hot | Rainy | Cool |
|------------|-----|-------|------|
| pH         | 4.4b | 4.2b  | 5.2a |
| Electrical conductivity (dSm⁻¹) | 0.08a | 0.08a | 0.03b |
| Organic matter (%) | 0.92a | 0.66b | 1.06a |
| Total nitrogen (%) | 0.46a | 0.033b | 0.052a |
| Available phosphorus (mgkg⁻¹) | 4.99a | 3.14a | 4.67a |
| Available potassium (mgkg⁻¹) | 51.1a | 32.6b | 47.4ab |
| Non-halophilic bacteria (log CFUg⁻¹ dry soil) | 6.44a | 5.59b | 6.15a |
| Slightly-halophilic bacteria (log CFUg⁻¹ dry soil) | 4.55a | 3.76b | 4.25a |
| Moderately-halophilic bacteria (log CFUg⁻¹ dry soil) | 3.81a | 3.32c | 3.60b |

abc Values with the same letter within rows indicate no significant difference with P ≥ 0.05.

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2.2.3. Data analysis

The values of soil physical and chemical properties and density of halophilic bacteria of each plot were averaged from its subplots. Data obtained from three seasons were compared by one-way analysis of variance (ANOVA) and the significance of mean difference among the three seasons was done by multiple comparison tests (Tukey’s HSD Post Hoc Test). Statistics analyses were performed using the SPSS version 17.0 (SPSS Inc., USA.).

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Fig. 1. Map of the study area: shaded area depicts the location of Na Si Nuan Secondary Forest at Maha Sarakham Province, Thailand.
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