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In situ and Analysis Dataset on Moso Bamboo (*Phyllostachys edulis*) in Zhejiang, China

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Abstract: Moso bamboo (*Phyllostachys edulis*) is one of the major forests in tropical and sub-tropical regions, it can sequestrate CO_2 with a high efficiency and serves as a key sources of livelihood for the locals. However, since more than 1/6 of the biomass above the ground is taken out of the forest land regularly, depletion of soil fertility in bamboo land becomes a challenging issue for sustainable moso bamboo ecosystem. Chlorophyll content (Chl) is an indicator of soil fertility, and establishing a relationship between *in situ* optical chlorophyll content (such as SPAD, unitless) and *in vitro* absolute chlorophyll content (Chl, μg/cm^2) will facilitate large scale soil fertility management. On 23 October 2018, 30 samples were collected from moso bamboo leaves in Deqing county, Zhejiang province, China (30º32′53.89″N, 119º55′1.27″E). The *in situ* SPAD readings range from 27.4 to 47.6, with an average of 40.47. The *in vitro* absolute chlorophyll content (Chl, μg/cm^2) was determined using 95% ethanol and 80% acetone (1:1), as well as spectrophotometer, with a span of 26.51–70.72 μg/cm^2 and an average of 51.84 μg/cm^2. Analysis of correlation suggests that the best relationship between SPAD and Chl (μg/cm^2) can be expressed as exponential ($Chl=5.8775e^{0.0525\times SPAD}$), with a coefficient of determination (R^2) of 0.9287. This dataset includes: 1) geographical location of sample site; 2) *in situ* SPAD readings and *in vitro* chlorophyll concentration measuring of moso bamboo (*P. edulis*) and the relation between them. The dataset is archived in .kmz, .shp and. xlsx data formats, consisting of 3 data files with data size of 31.6 KB (Compressed to 2 files with the data size of 28.4 KB).

Keywords: Zhejiang; moso bamboo; *Phyllostachys edulis*; chlorophyll; in situ; SPAD

1 Introduction

Moso bamboo is a plant widely distributed in sub-tropical and tropical regions of the East Asia. It is one of many members in *Phyllostachys* of *Bambusoideae*. Like some bamboos in *Phyllostachys,* moso bamboo lacks a unique Latin name because it lacks the key information for classification: flower. As a result, many Latin names may be used in literature. Never-

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[2] Wang, Z. X., Li, F. Dataset of *in Situ* SPAD readings, *in Vitro* chlorophyll concentration measuring, and their relationship: Moso bamboo (*Phyllostachys edulis*) in Zhejiang, China [DB/OL]. Global Change Research Data Publishing & Repository, 2019. DOI: 10.3974/geodb.2019.03.05.V1.

theless, "*Phyllostachys pubescens*" is used in *Flora of China* (Volume 9, Issue 1)[1], and "*Phyllostachys edulis*" is also popular[2].

Moso bamboo forest is an efficient ecosystem, with a biomass of 115 t/hm^2, only after ever green broad leaved forest (399 t/hm^2) and mixed forest (378 t/hm^2), more than secondary forests (114 t/hm^2) and *P. massoniana* forest (10^9 t/hm^2). With a short logging cycle (<6 years), moso bamboo sequestrates carbon roughly equivalent to 1/6 of its biomass annually[3–4]. Moso bamboo is also a major economic source for locals, revenues from bamboo products have increased from 1.7×10^{10} RMB in 2000, to 23.59×10^{10} RMB in 2017[5]. Besides direct income from bamboo products, a study suggests that the total value of bamboo ecosystem services is 21,081 RMB/ hm^2, 9.35 times as much as its direct income[6]. More revenues are expected with the advance of science and technology[7–9].

The fact that more than 1/6 of above ground biomass are removed out of the field means a big loss of soil fertility, a challenging issue for its sustainability[10]. Although some well managed bamboo fields can yield bamboo sprout in good quantity and quality, and its early-maturing bamboo shoot can also supply golden market before the Spring Festival[11], most of them remain poorly managed. The experiences in crop science[12] suggest that two approaches may be used to better manage the soil fertility: directly analyze soil fertility with traditional techniques; or indirectly measure chlorophyll concentration (Chl) of bamboo leaves as a proxy for soil fertility. The latter is relatively quick and less costly, but still requires comparing the "actual Chl" with "normal Chl". The tricky point for moso bamboo is that "the normal Chls"vary according to many factors, such as provenance[13–14], on and off-year period[15], leaf age[16–17], leaf location in crown[18], and seasonality (phase of leaf)[19]. Therefore, a more effective method is needed to conduct large scale Chl monitoring. The present paper builds a statistical model for moso bamboo by measuring optical meters of leaf chlorophyll in field (*in situ* SPAD), and by analyzing actual leaf chlorophyll concentration in laboratory (*in vitro* Chl).

2 Metadata of Dataset

The metadata of the dataset[20] are summarized in Table 1.

3 Methods

3.1 *In Situ* Sampling and Optical Measurement of Leaf Chlorophyll: SPAD

(1) Location and Date: The sampling was conducted at Deqing County, Zhejiang province, on October 23, 2018 (Table 1). The sampling site is located in a smooth, south-facing slope, covered with 3–5 year moso bamboo. The earlier publications[17,19] suggest that October may be near the prime time for Chl, thus the normal leaves are dark green. However, some less green leaves are included in the samples to broaden the span of the spectrum.

(2) Pre-processing: Leaves were first rinsed with tap water, and then were ranked according to their greenness. All samples were classified into 30 groups. Each consists of 4-6 leaves.

(3) Measurement of SPAD: Each leaf was measured at ten locations using SPAD-502 meter. The leaves with large SPAD deviation from group average (>1.5) were reclassified into relevant groups.

Table 1 Metadata summary of the "Dataset of *in Situ* SPAD readings, *in Vitro* chlorophyll concentration measuring, and their relationship: moso bamboo (*Phyllostachys edulis*) in Zhejiang, China"

Items	Description
Dataset full name	Dataset of *in Situ* SPAD readings, *in Vitro* chlorophyll concentration measuring, and their relationship: moso bamboo (*Phyllostachys edulis*) in Zhejiang, China
Dataset short name	Chlorophyll_MosoBambooZhejiang
Authors	Wang, Z. X. L-5255-2016, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, wangzx@igsnrr.ac.cn Li, F. L-3424-2018, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, lif@igsnrr.ac.cn
Geographic region	Deqing county, Zhejiang province, China (30º32′53.89″N, 119º55′1.27″E; 65 m a.s.l.)
Date	October 23, 2018 Data format .shp, .kml, .xlsx
Data size	20.9 KB (after compression: 17.8 KB)
Data files	8 files were compressed into two files (1) Site location: 1.shp file, 1 kml file; (2) SPAD and Chlorophyll measurements: 1 .xlsx file
Foundation	Ministry of Science and Technology of P. R. China (2016YFA0600201)
Data publisher	Global Change Research Data Publishing and Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (data products), and publications (in this case, in the *Journal of Global Change Data & Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license, and; (4) If ***Data*** are used to compile new datasets, the 'ten percent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[21]

3.2 Preservation of Samples

Wet ice was used to reserve the samples: wrap plastic sample bag with wet towel; and wrap wet ice with dry towel, to prevent frost resulted from direct contact of leaves and ice. It took 12 hours to send samples from site (Deqing county, Zhejiang) to laboratory (Nanjing University, Jiangsu).

3.3 *In Vitro* Measurement of Absolute Leaf Chlorophyll Concentration: Chl

Unit of Chl: Leaf Chlorophyll Content (Chl) will be represented on an area basis ($\mu g/cm^2$).

Sample Preparation: the sample size is determined by referencing 0.05 g (fresh weight), adjusted according to leaf colors: more samples are needed if leaves are less green. Note that only sample "area" is used for following Chl calculation, not "fresh weight". The actual area for 30 samples range from 4 cm^2 to 9 cm^2. The prepared samples were wrapped by aluminium foils and kept into liquid nitrogen on October 24, and the analysis was resumed on November 9, under the lab's work schedule.

Extraction of Chlorophyll: The solvent used to extract chlorophyll is 25 mL 80% acetone and 95% ethanol (1:1). The test tubes were coated with aluminium foils and put in dark.

Measurement of absorbance of the extract and Chl quantification: After the samples in test tubes became white or transparent, the absorbance of the extract was measured with spectrophotometer, and the Chl was calculated using following formulas:

$$Chla=11.24A_{661.6}-2.04A_{644.8} \quad (1)$$

$$Chlb=20.13A_{644.8}-4.19A_{661.6} \quad (2)$$

$$Chl=7.05A_{661.6}+18.09A_{644.8} \quad (3)$$

where Chla is the concentration of chlorophyll a (μg/mL), Chlb is the concentration of chlorophyll b (μg/mL), Chl is total chlorophyll concentration (μg/mL), $A_{661.6}$ and $A_{644.8}$ are absorbance of the extract in 661.6 nm and 644.8 nm, respectively. Chl (μg/mL) can be transformed into Chl (μg/cm^2) using sample area (cm^2) and solvent volume (25 mL).

4 Results

The dataset[20] consists of three files: one in excel format (*in situ* optical measurements, SPAD; and *in vitro* absolute measurement, Chl, μg/cm^2); two for location of sampling in shp and kml formats.

4.1 Optical SPAD and Absolute Chl

According to Table 2, SPAD ranges from 27.4 to 47.6, with an average of 40.47; and Chl ranges from 26.51 to 70.72 μg/cm^2, with a mean of 51.48 μg/cm^2.

Table 2 Statistics of SPAD and chlorophyll

Index	Statistics parameter						
	Samples	Minimum	Maximum	Mean	Median	Stdev	CV (%)
SPAD	30	27.4	47.6	40.47	41.25	6.41	15.84
Chl (μg/cm^2)	30	26.51	70.72	51.48	55.04	14.99	28.92

4.2 Relationships between SPAD and Chl

Correlation relationships between SPAD and Chl were analyzed and four types of regression models were developed (Table 3). According to Coefficient of Determination (R^2), the best-fit of SPAD-Chl for total chlorophyll is exponential regressive model, with a R^2 of 0.928,7. Within Chl, the SPAD-Chl relation for chlorophyll a (Chl a) is better than that for chlorophyll b.

Table 3 Relationship between SPAD and Chl for moso bamboo, y= Chl (μg/cm^2), x=SPAD

Chlorophyll	$y=ax+b$	$y=ax^b$	$y=ae^{bx}$	$y=a\ln(x)+b$
Chla	$y = 1.5982x-28.08$ $R^2 = 0.914,6$	$y = 0.0258x^{1.9544}$ $R^2 = 0.950,2$	$y = 3.8058e^{0.0546x}$ $R^2 = 0.948,4$	$y = 56.343\ln(x)-171.1$ $R^2 = 0.888,7$
Chlb	$y = 0.6123x-9.5428$ $R^2 = 0.760,3$	$y = 0.0265x^{1.71}$ $R^2 = 0.782,8$	$y = 2.0509e^{0.0483x}$ $R^2 = 0.798,2$	$y = 21.441\ln(x)-63.798$ $R^2 = 0.728,7$
Chla+Chlb	$y = 2.2107x-37.631$ $R^2 = 0.892,3$	$y = 0.0491x^{1.8746}$ $R^2 = 0.925,2$	$y = 5.8775e^{0.0525x}$ $R^2 = 0.928,7$	$y = 77.791\ln(x)-234.93$ $R^2 = 0.863,8$

4.3 Relationship of Chlorophyll Concentration and Chla/Chlb Ratio

Figure 2 illustrates the relation between chlorophyll content and Chla/Chlb ratio: when Chl is above 30 μg/cm^2, there is a relatively stable Chla/Chlb ratio about 2–2.8; when Chl is less than 30 μg/cm^2, Chla/Chlb ratio is more scattered, but with a declining pattern.

4.4 Validation and Accuracy Assessment

Xu[22] suggests that the normal range of Chl for healthy plants is 40–60 μg/cm^2，and Chla/Chlb ratio be about 3 for healthy heliophytes (sun-grown leaves), and a bit smaller for mesophytes and sciophytes. The samples of the present study are from middle or lower crown of moso

bamboo, thus belong to mesophyte or sciophyte (shade-grown) leaves. With a mean Chl of 51.48 μg/cm^2, and a Chla/Chlb ratio of 2–2.8, these results comply with Xu's suggestion.

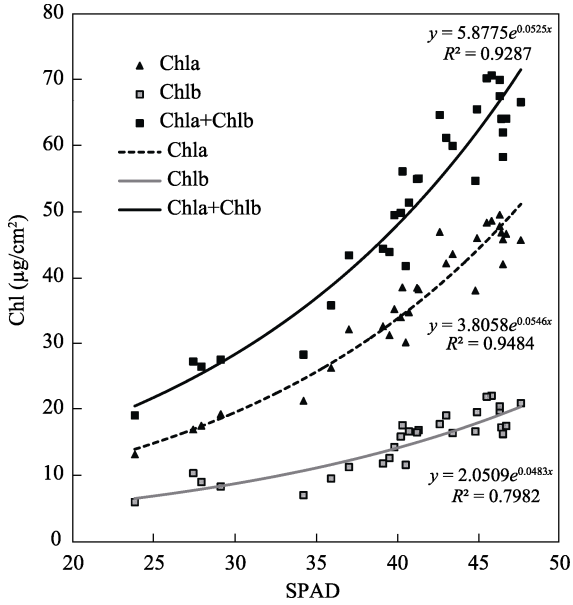

Figure 1 Exponential regression of SPAD and chlorophyll concentration for moso bamboo

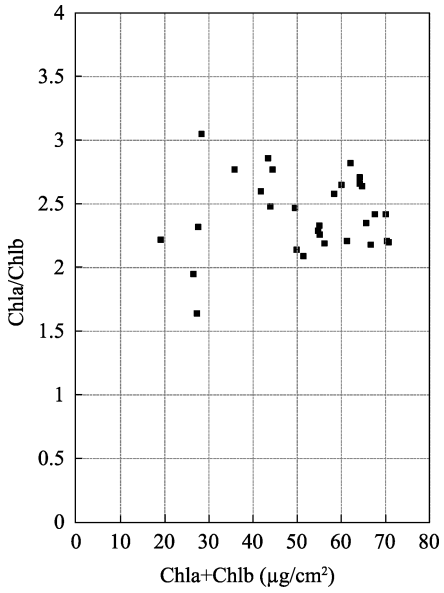

Figure 2 Relationship of chlorophyll concentration and Chla/Chlb ratio for moso bamboo

5 Discussion and Conclusion

(1) Currently, only Qiu[13] uses "area-based method (μg/cm^2)" to express the chlorophyll concentration of *Phyllostachys pubescens*, which can be compared approximately with the present study. In Qiu's study, the highest chlorophyll content occurred in October, with an average of 84.52 μg/cm^2 for nine provenances, which was significantly higher than the reference from Xu[22] (40–60 μg/cm^2), also higher than the present study (mean=51.48 μg/cm^2, max=70.72 μg/cm^2).

(2) On October 23, 2018, the relative chlorophyll values (SPADs) of *Phyllostachys pubescens* in Mogan Mountains of Zhejiang Province were measured and its actual values were analyzed in laboratory. The exponential regressive model is the best SPAD-Chl equation in terms of coefficient of determination (R^2), with a R^2 of 0.928,7, which means SPAD can determine 92.87% of the variance of Chl. Whether the model can be extended to other regions and other seasons needs further study. We suggest that the area-based method be used to express chlorophyll density in future studies, and field observations and laboratory method be described in detail in order to compare and synthetically analyze the results of the study.

Author Contributions

Wang, Z. X. designed the development of dataset and wrote the data paper. Li, F. was responsible for *in situ* sampling and SPAD measurement.

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