Near Infra-Red Spectroscopy Predicts Crude Protein in Hemp Grain

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Abstract

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Plain Language Summary

Earthquake data for the island of La Palma from the September 2021 eruption is found …

1 ABSTRACT

2 INTRODUCTION

Hemp (Cannabis sativa L.) is an annual crop with potential uses as a source of food or feed from grain, and bast fiber or hurd from the stalk. Hemp cultivars are commonly grown for one or both purposes. Here, researchers are concerned with the assessment of percent crude protein (CP) in hemp grain using near-infrared spectroscopy (NIRS).

Hemp grain with higher percent CP is of interest to researchers, producers, and consumers because of protein's nutritional value. The protein content of whole hemp seed approximately 25-30 % dry matter (Bárta et al., 2024).

NIRS technology is rapid, non-destructive, and cheap. Within the context of plant breeding, a sample of undamaged grain may subsequently be planted. NIRS technology has been used since the 1970's to assess oil seeds Williams (1975).

A calibration set typically consists of samples from many environments encompassing the range of expected values from the analyte (Chadalavada et al., 2022). For this study, a benchtop NIR spectrometer was used to develop a model to predict crude protein content based on a data set representing multiple years, locations, and cultivars.

3 MATERIALS AND METHODS

Source: Article Notebook

3.1 Hemp Grain Sample Background

Spectral data were obtained from whole (unground) hemp grain samples, harvested at maturity, collected from 2017 - 2021 from 18 cultivar trials in New York (NY) (149 samples). Grain samples were obtained by hand sampling or mechanical harvest and were cleaned of chaff and dried at 30 C for six days in a forced-air dryer. In total, 39 cultivars were represented in the data set. Cultivars were grain or dual-purpose types and included both commercially available and experimental material.

All cultivar trials were planted in randomized complete block design with each cultivar replicated four times. The 2017 data were comprised of samples from the same thirteen cultivars sampled from six NY locations. For those trials, grain was harvested from each plot individually and aggregated by cultivar. Four subsamples were drawn from each aggregated sample and scanned separately. These spectra were averaged at each 2 nm increment. All remaining samples from 2018 - 2021 were collected on a per-plot basis. All possible cultivars and possible locations were represented in 2017, but only a selected subset of cultivars and locations were represented in 2018-2021.

3.2 Spectral Data Collection

A benchtop NIR spectrometer (FOSS/ NIR FOSS/ NIR Systems model 5000) was used to obtain the spectra (FOSS North America, Eden Prairie, MN, USA). Spectra were collected every 2 nm from 1100-2498 nm and the logarithm of reciprocal reflectance was recorded.

WINISI software version 1.02A (Infrasoft International, Port Matilda, PA, USA) was used to average the spectra in 2017, as well as to select samples for laboratory assay from 2018-2021. Samples were selected for assay according to their spectral distance from their nearest neighbor within the calibration data set with a cutoff of a distance of 0.6 H, where H is approximately equal to the squared Mahalanobis distance divided by the number of principal components used in the calculation (Garrido-Varo et al., 2019). For selection, spectra were preprocessed using SNV-detrend with settings 1,4,4,1 for the derivative, gap, smooth, and smooth 2 settings respectively.

3.3 Software used:

Additional analysis was performed

3.4 Preprocessing

Multiplicative scatter correction (MSC)

standard normal variate (SNV) transformation

The calibration set consisted of

The validation set consisted of

3.5 Laboratory Validation

Laboratory assays were performed by Dairy One Forage Laboratory (Ithaca, NY). For those assays, 1mm ground samples were analyzed by combustion using a CN628 or CN928 Carbon/Nitrogen Determinator.

Prior to In 2017, an in

4 RESULTS AND DISCUSSION

In wheat, heritability of grain protein content has an estimated range of values from 0.4 - 0.7 Geyer et al. (2022)

5 ACKNOWLEDGMENTS

6 SUPPLEMENTAL MATERIAL

7 OPTIONAL SECTIONS

8 REFERENCES

9 FIGURES AND TABLES

Source: Article Notebook

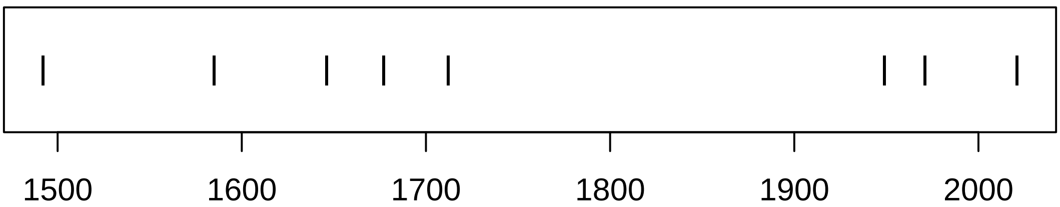

Figure 1: Timeline of recent earthquakes on La Palma

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Source: Article Notebook

Based on data up to and including 1971, eruptions on La Palma happen every 79.8 years on average.

Studies of the magma systems feeding the volcano, such as (**marrero2019?**), have proposed that there are two main magma reservoirs feeding the Cumbre Vieja volcano; one in the mantle (30-40km depth) which charges and in turn feeds a shallower crustal reservoir (10-20km depth).

Eight eruptions have been recorded since the late 1400s (Figure 1).

Data and methods are discussed in Section 10.

Let x denote the number of eruptions in a year. Then, x can be modeled by a Poisson distribution

$$p(x) = \frac{e^{-\lambda}\lambda^{x}}{x!} \tag{1}$$

where λ is the rate of eruptions per year. Using Equation 1, the probability of an eruption in the next t years can be calculated.

Table 1: Recent historic eruptions on La Palma

Name	Year
Current	2021
Teneguía	1971
Nambroque	1949
El Charco	1712
Volcán San Antonio	1677
Volcán San Martin	1646
Tajuya near El Paso	1585
Montaña Quemada	1492

Table 1 summarises the eruptions recorded since the colonization of the islands by Europeans in the late 1400s.

La Palma is one of the west most islands in the Volcanic Archipelago of the Canary Islands (Figure 2).

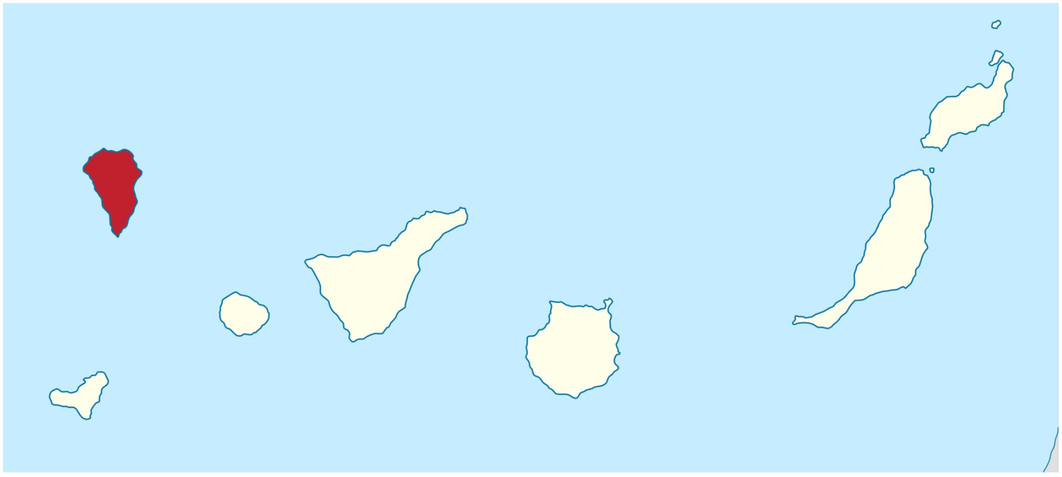

Figure 2: Map of La Palma

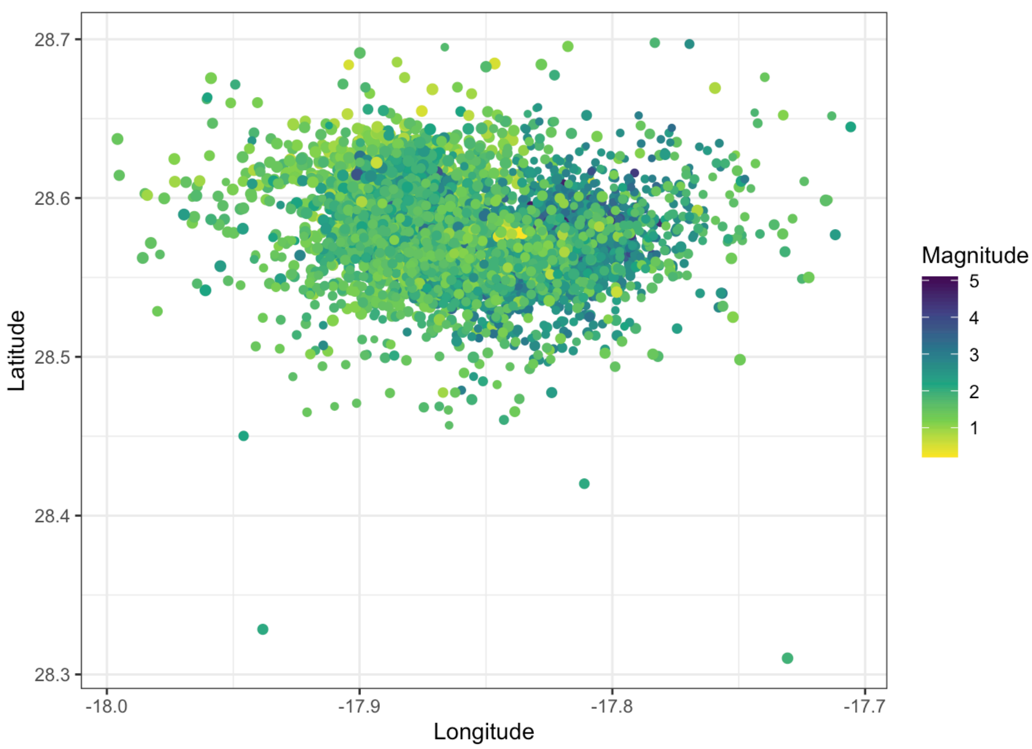

Figure 3: Locations of earthquakes on La Palma since 2017

Source: Explore Earthquakes

Figure 3 shows the location of recent Earthquakes on La Palma.

10 Data & Methods

11 Conclusion

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