Joint measurements of NDVI and crop production data-set related to combination of management zones delineation and nitrogen fertilisation levels

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ABSTRACT

This research compared four nitrogen (N) management strategies (uniform N rate: UR, variable N rate based on crop proximal sensing: VR-PS, variable N rate based on management zones: VR-MZ and variable N rate based on integrating crop sensing and MZ: VR-PSMZ), evaluating their effect on maize grain yield, partial factor productivity (PFPN), and net return above N fertiliser cost (RANC). The study provided a practical tool for choosing the fertilisation strategy that best performs in each agro-environment. These datasets are a supplementary material to the research paper by [3]. Data were collected over seven site-years experiments conducted in North-Eastern Colorado (USA). In dataset 1, for each site-year, data includes geo-referred points where grain yield and Normalised Difference Vegetation Index (NDVI) were measured, each one associated with its respective N rate, management zone (MZ), PFPN, RANC, and N management strategy. In order to group the observations reflecting homogeneous crop vigour, NDVI values were clustered within NDVI classes. In dataset 2, the main soil properties measured in several geo-referred points in each location are provided.

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Specifications Table

| Subject                                      | Agronomy and Crop Science |
|----------------------------------------------|---------------------------|
| Specific subject area                        | Precision agriculture, precision N fertilisation |
| Type of data                                 | Tables                     |
| How data were acquired                       | Dataset 1                  |
|                                              | Coordinates: Aggregated coordinates (m) |
|                                              | NDVI: GreenSeeker handheld optical sensor |
|                                              | Grain yield: Combine harvester equipped with GPS |
|                                              | Dataset 2:                  |
|                                              | Coordinates: Aggregated coordinates (m) |
|                                              | Sand: hydrometer            |
|                                              | Silt: hydrometer            |
|                                              | Clay: hydrometer            |
|                                              | Organic matter: loss-on-ignition pH: 1:1 water-soil |
|                                              | Nitrate N: Cd reduction     |
|                                              | CEC: sum of exchangeable K, Ca, Mg, and neutralisable acidity |
|                                              | Available P: Olsen method   |
|                                              | Exchangeable K: ammonium acetate |
| Data format                                  | Dataset 1:                  |
|                                              | Raw                        |
|                                              | Derived (variables calculated from raw data) |
|                                              | Dataset 2:                  |
|                                              | Raw                        |
| Parameters for data collection               | Dataset 1                  |
|                                              | NDVI was measured around noon, by holding the GreenSeeker about 0.8 m above maize canopy, |
|                                              | Maize yield was determined at physiological maturity using a combine harvester equipped with a GPS receiver, |
|                                              | GPS signal was improved with differential correction provided by Omnistar VBS signal and had a geometric precision of 1m horizontally, |
|                                              | Dataset 2                  |
|                                              | Soil samples were acquired before sowing, after tillage, |
| Description of data collection              | Dataset 1                  |
|                                              | NDVI values were acquired continuously, walking at a constant speed, alternatively along the maize rows, attributed each to a specific management zone and characterised by a specific fertilisation level. NDVI values were then clustered to obtain NDVI class, following the statistical procedure detailed in Ref. [3]. |
|                                              | Maize yield was referred to an area including 2 rows, and attributed to a specific management zone and fertilisation level too. |
|                                              | Points were attributed to different N management strategies following specific conditions reported in Ref. [3]. |
|                                              | Dataset 2                  |
|                                              | Geo-referred soil samples were collected at 0–20 cm depth, following a random grid (40 m) spatial survey. |
| Data source location                         | Colorado State University, Fort Collins, CO 80523, USA |
| Data accessibility                           | Data are on a public repository, Repository name: Mendeley Data |
|                                              | Data identification number: [NDVI measurements connected to specific N fertilisation levels and management zones.] |
|                                              | Direct URL to data: [https://data.mendeley.com/datasets/phzdwr487g] [We highly recommend Mendeley Data if you do not have a trusted repository.] |
| Related research article                     | This dataset is associated to the research paper by Ref. [3]. |

Value of the Data

- Data provides a practical tool for choosing the best N fertilisation strategy (NDVI map, management zone delineation, their integration) in a specific agro-environment, on the basis of the quantification of spatial patterns in grain yield.
- Data are useful for the scientific community, as researchers can build similar experiment in other agro-environments, thus evaluating the possibility of using precision N fertilisation on maize production.
- Data allowed evaluating the effect of each fertilisation strategy on crop productivity, environmental sustainability, as well as farmers’ profitability across different agro-environments.
1. Data

Four nitrogen (N) management strategies adopted in maize production were compared in 7 site-years: uniform N rate (UR), variable N rate based on crop proximal sensing (VR-PS), variable N rate based on management zones delineation (VR-MZ), and variable N rate based on both PS and MZ (VR-PSMZ). These N management strategies were investigated for their effect on maize grain yield, partial factor productivity (PFPN), as well as on net return above N fertiliser cost (RANC). Precision fertilisation strategies have been demonstrated as promising tools for improving PFPN without negatively impacting maize grain yield, then increasing farmers’ profitability. The N management strategy that maximise RANC was considered the best in each site-year. The spatial range in grain yield data has been demonstrated to be a practical tool for choosing the best N management strategy in each situation. The UR performed the best where no spatial structure existed. The VR-MZ was the best strategy with high spatial range (>100 m), while for spatial range <10 m performed better. Conversely, for intermediate values, VR-PSMZ improved maize fertilisation.

Information reported in the two datasets allow repeating the analysis in different agro-environments.

2. Experimental design, materials, and methods

The experiment was carried out in four different sites in north-eastern Colorado (USA), in locations 1 (site-years 1 and 5), 2 (site-year 2), 3 (site-year 3), 4 (site-years 4, 6 and 7), during three growing seasons (2014, 2015, and 2016). Locations 3 and 4 were experimental sites of Colorado State University, while locations 1 and 2 were commercial farm fields.

The experimental setup was created to allow the comparison of four different N management strategies in maize production:
- Uniform N rate (UR)
- Variable rate N management based on crop proximal sensing (VR-PS)
- Variable rate N management based on MZ delineation (VR-MZ)
- Variable rate N management based on both crop proximal sensing and MZ delineation (VR-PSMZ)

2.1. Soil sample collection

Before starting the experiment, soil samples were collected within each field prior to planting, in geo-referred points, at 0–20 cm depth. Soil sampling design followed a random within grid (40 m) spatial survey. Soil samples were then air-dried and analysed in a commercial laboratory (Ag Harris, Lincoln, NE) to determine the main soil properties (texture\(^a\), soil organic matter\(^b\), pH\(^c\), nitrate\(^d\), cation exchange capacity\(^e\), available P\(^f\), exchangeable K\(^g\)). Superscript indicates the method of measurement: a: hydrometer, b: loss-on-ignition, c: 1:1 water-soil, d: Cd reduction, e: Summation of exchangeable K, Ca, Mg and neutralisable acidity, f: Olsen method, g: ammonium acetate.

2.2. Crop agronomic management

Several N rates were tested in each site-year, defining a standard N dose on the basis of farmer’s applied rate. Then, other N rates were tested, reducing or increasing N rates to comply with MZ productivity or NDVI response. The N treatment strips were randomly distributed within each field. The strips width was equal to the width of the fertiliser sprayer used by the farmer, while the length was enough to contain at least 15 yield data point. All N was supplied using urea ammonium nitrate (UAN 32% N), placed in strips close to plant rows at the V6 growth stage of maize.

2.3. NDVI measurements

Geo-referred crop canopy reflectance data were measured using GreenSeeker (Trimble, Sunnyvale, California, USA) handheld active canopy sensor, determining canopy reflectance at 660 and 770 nm,
then calculating NDVI. The instrument was maintained about 0.80 m above maize canopy and walking at a constant speed along the maize rows, according to the manufacturer’s instruction manual.

2.4. Grain yield determination

At harvest, grain yield was determined. Maize was harvested at physiological maturity, using a combine harvester equipped with a GPS receiver, to ensure that grain yield data were geo-referred. Then grain yield values were adjusted to a moisture content of 15.5%.

2.5. Partial factor productivity of nitrogen (PFPN) calculation

PFPN was calculated, as the ratio between grain yield and total N supply, both expressed in kg ha$^{-1}$ [2].

2.6. Net return above N fertiliser cost (RANC) calculation

RANC was calculated according to Ref. [1], as the difference between grain yield market price value and N fertiliser cost. Maize grain price was considered equal to 0.15 $ kg$^{-1}$, 0.14 $ kg$^{-1}$, and 0.13 $ kg$^{-1} for 2014, 2015, and 2016, on the basis of [4].

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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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dib.2019.104968.

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