Data Article

A dataset on above- and below-ground traits of 21 species found in banana cropping systems, cultivated individually

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\textbf{A R T I C L E   I N F O}

\textbf{Article history:}
Received 19 April 2020
Revised 11 June 2020
Accepted 11 June 2020
Available online 20 June 2020

\textbf{Keywords:}
Cover crops
Leaf traits
Plant traits
Root traits
Light acquisition
Nutrient acquisition
Banana
Weeds

\textbf{A B S T R A C T}

The data presented in this article describe 21 species that can be found in banana cropping systems: 17 cover crops species, 2 spontaneous species and 2 cultivars of banana. The cover crop species belongs mainly to Fabaceae family, but also to Poaceae, Euphorbiacea and Asteraceae. Four repetition of each species were cultivated individually, in the field, under non-limiting conditions. 40 variables were measured on whole plant, leaves and roots, at flowering or after six months of growth for longer cycle species. This dataset is made available to provide data on these species, enable comparisons between datasets and meta-analysis on cover crop or on species presented in arable fields. The data presented in this article were used in the research articles entitled “Trait-based characterisation of cover plants’ light competition strategies for weed control in banana cropping systems in the French West Indies” (Tardy et al. 2015) and “Trait-based characterization of soil exploitation strategies of banana, weeds and cover plant species” (Tardy et al. 2017).

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https://doi.org/10.1016/j.dib.2020.105890
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Specifications Table

| Subject | Agricultural and Biological Sciences (General) |
|---------|-----------------------------------------------|
| Specific subject area: | Description of aboveground and underground traits related to competition for resources of 17 cover crops, 2 spontaneous species and 2 cultivars of banana. |
| Type of data: | Table |
| How data were acquired: | Field measures of plants grown individually in the field. |
| Instruments and methods: | Scanner and WinRhizo Pro-analytical software (Regent Instruments) for leaf and root measurements |
| Data format: | CHN analyser (Elementar Vario Macro Cube) and Dumas method for leaf total N quantification |
| Parameters for data collection: | Type of soil: andosols |
| Irrigation: | rain-fed regime, cumulated annual precipitation 2829 mm |
| Fertilisation: | 50 g of urea (46% N) applied at the base of each plant at the beginning of the experiment. |
| Temperature: | 25.6 °C averaged over the experiment, ranging from 22.8 °C to 29.7 °C. |
| Plants were grown individually, in the field, in separated 16 m² plots. |
| Description of data collection: | The data were collected on each plants (4 per species/cultivars) at flowering for short cycle species, and after ~6.5 months of growth for longer cycles or perennial plants. Well-exposed leaves were separated to determine some traits according to standardized protocols in ecology (SLA, LDML, LNC). The rest of the plants were separated into stems, petioles and leaf blades and weighted. A 1-m deep and 1-m wide trench that was dug 20 cm from the base of each plant. The root intersections in the vertical soil profile were counted on a 5 cm × 5 cm mesh grid. For each plant, three cubes of 1000 cm³ of soil samples were removed at different positions in the root system. |
| Data source location: | City/Town/Region: Experimental station of Neufchateau, Capesterre Belle Eau |
| Country: Guadeloupe, French West Indies |
| Latitude and longitude (and GPS coordinates) for collected samples/data: | 16°05’N, 61°35’W |
| Data accessibility: | Repository name: Cirad Dataverse |
| Data identification number: | / |
| Direct URL to data: | doi:10.18167/DVN1/HIEXNF |
| Related research article: | Tardy F., Damour G., Dorel M., Moreau D. 2017. Trait-based characterization of soil exploitation strategies of banana, weeds and cover plant species. PlosOne, 12(3): e0173066. |
| http://dx.doi.org/10.1371/journal.pone.0173066 |
| Tardy F., Moreau D., Dorel M., Damour G. 2015. Trait-based characterisation of soil exploitation strategies of banana, weeds and cover plant species. European Journal of Agronomy, 71: 10–18. http://dx.doi.org/10.1016/j.eja.2015.08.002 |

Value of the Data

The data represent leaf, root and plant trait values of 21 species that can be found in banana cropping systems: 17 cover crops species, 2 spontaneous species and 2 cultivars of banana. They could be used by other researchers who need data on these species/varieties. The data enable other researchers to compare their own data with this dataset and to extent their analysis. These data could be used in meta-analysis on cover crops or on species present in arable fields.

Data description

The dataset presented in this article (doi:10.18167/DVN1/HIEXNF) is composed of 40 variables measured on 17 species of cover crops, 2 spontaneous species widely present in banana agrosys-
items in the French West Indies and 2 cultivars of banana, at flowering or after six months of growth for longer cycle species. The banana cultivars were: cultivar ‘002’ (MusaAAA, Cavendish subgroup, Bcav), which is currently used for produce bananas for export all over the world, and the hybrid cultivar ‘Cirad925’ (Musa AAA, a new synthetic hybrid from CIRAD, B925), which shows improved resistance to the fungus *Mycosphaerella fijiensis*. The list of the species and varieties studied is provided in Table 1, along with their taxonomic groups, families and type (cover crop, spontaneous, banana). The cover crop species belongs mainly to Fabaceae family (12 species), but Poaceae (3 species), Euphorbiaceae (1 species) and Asteraceae (1 species) were also studied. The spontaneous species belongs to Asteracea and Cucurbitacea families. The list of the variables is provided in Table 2 and 3. Some of them refer to whole plant (7 variables), leaves (21 variables), and roots (12 variables). Only one variable is a categorical variable, the other ones were quantitatively measured. Some variables are raw variables, while others were calculated. Calculation formulas are provided in Table 2. The length of the growth period before flowering (and the observation) is also provided.

### Experimental design, materials, and methods

The experiment was conducted at the CIRAD experimental station of Neufchâteau in Guadeloupe (French West Indies), for a period of six months (24 April – 6 November 2013), in a 0.4 ha field previously used as fallow [1]. Soil was andosol (FAO World reference base for soil resources) and plants were rainfed. Cumulated precipitation, mean temperature and mean total solar radiation provide favourable conditions for plant growth all year round (respectively 2829 mm, 25.6 °C and 462 +/- 40M] m² month⁻¹ over the period of the experiment). Fertilisation and weed management around the plants [1; 2] were conducted in order to ensure non-limiting conditions of plant growth and to assess their growth potential in the field. Four plants of the twenty one species/cultivars (see ‘Data description’ and Table 1) were sown manually in separate 16 m² plots distributed randomly within 6 blocks in the field. These four plants corresponded to four repetitions per species/cultivar. On each plants, we measured variables and traits that we assumed related to resource acquisition [see 1; 2]. Traits were measured on each plants i) for short cycle species, when half the twigs had flowered, ii) for long cycles or perennial plants.
Table 2
List of the aboveground variables provided in the dataset.

| Abbreviations | Variable names | Units | Organs | Calculation |
|---------------|----------------|-------|--------|-------------|
| H             | Standing vegetative height | cm     | plant  |             |
| W1            | Maximal crown width | cm     | plant  |             |
| W2            | Crown width perpendicular to W1 | cm     | plant  |             |
| A             | Crown projected area | m²     | plant  | pi * W1 * W2 |
| DW₁           | Stem dry weight | g      | plant  |             |
| DW₁,we        | Leaf blade dry weight of well-exposed leaves | g      | leaf   |             |
| DW₁,we        | Petiole dry weight of well-exposed leaves | g      | leaf   |             |
| DW₁,leaf,we   | Leaf dry weight of well-exposed leaves | g      | leaf   | DW₁,we + DW₁,we |
| DW₁           | Leaf blade dry weight | g      | leaf   |             |
| DW₁,leaf      | Leaf dry weight | g      | leaf   | DW₁ + DW₁,leaf |
| BMa           | Aboveground dry biomass | g      | plant  |             |
| PBR           | Petiole to leaf blade weight ratio | g/g    | plant  |             |
| LMFa_b        | Aboveground leaf mass fraction without petioles | g/g    | leaf   | DW₁/BMa |
| LMFa          | Aboveground leaf mass fraction with petioles | g/g    | leaf   |             |
| LDMC          | Leaf dry matter content | mg/g   | leaf   |             |
| LDMC_plt      | Leaf dry matter content at plant scale | mg/g   | leaf   |             |
| SLA_b         | Specific leaf area without petioles | m²/kg  | leaf   |             |
| SLA           | Specific leaf area with petioles | m²/kg  | leaf   |             |
| SLA_b,ps      | Specific leaf area without petioles at the plant scale | m²/kg  | leaf   |             |
| SLA_b,ps      | Specific leaf area with petioles at the plant scale | m²/kg  | leaf   |             |
| LAR_b,ps      | Aboveground leaf area ratio without petioles at the plant scale | m²/kg  | leaf   | LMFa_b * SLA_b,ps |
| LAR            | Aboveground leaf area ratio with petioles | m²/kg  | leaf   | LMFa * SLA_b |
| LAR_b         | Aboveground leaf area ratio without petioles | m²/kg  | leaf   | LMFa_b * SLA_b |
| LAR_a         | Aboveground leaf area ratio with petioles | m²/kg  | leaf   | LMFa * SLA_b |
| LA             | Total leaf blade area | m²     | leaf   |             |
| LSA            | Leaf to soil ratio | m²/m² | leaf   | LA/A        |
| LNC            | Leaf dry matter content | %      | leaf   |             |

Table 3
List of the underground variables provided in the dataset.

| Abbreviations | Variable names | Units | Organs |
|---------------|----------------|-------|--------|
| RD_max        | Maximal rooting depth | cm     | root   |
| RD_med        | Median rooting depth | cm     | root   |
| RW_max        | Maximal rooting width | cm     | root   |
| Nod           | Nodule activity | categorical | root   |
| Diam          | Mean root diameter | mm     | root   |
| SRL           | Specific root length | m/g    | root   |
| RLD           | Root length density | cm/cm³ | root   |
| RWD           | Root weight density | g/cm³  | root   |
| RID₂₀-20      | Root impact density in the 0–20 soil layer explored by the roots | /dm² | root   |
| RID₂₀-40      | Root impact density in the 20–40 soil layer explored by the roots | /dm² | root   |
| RID₄₀-60      | Root impact density in the 40–60 soil layer explored by the roots | /dm² | root   |
| RID₆₀-80      | Root impact density in the 60–80 soil layer explored by the roots | /dm² | root   |

at the end of the experiment (i.e. after ~6.5 months of growth). The length of this growth period was reported as the number of days after sowing (DAS). Traits measurements methods are provided in the related research articles [1; 2], however, we provide deeper information below.

Aboveground measurements

All measured variables are presented in Table 2.

The standing vegetative height and crown widths were measured at one sampling date per species, with a tape measure. Standing vegetative height (H) was measured from the bottom of
the plant at the soil interface to the top of the higher vegetative organ, without stretching the plant. We considered that the crown projection on the soil could be modelled by an ellipse. Two crown widths were then measured: W1, the maximal crown width and W2, the crown width perpendicular to W1. The crown projected area (A) was then calculated (Table 2).

At the top of each plant, three well-exposed leaves were harvested precociously, according to standardized protocols for the measurement of SLA [3]. Just after harvest, the leaves were placed in a plastic bag containing wet paper and stored in a cooler for less than 15 min. Then, the petioles and leaf blades were weighed and scanned at 200 dots per inch (scanner Epson expression 10,000XL Pro) separately. They were then oven dried at 70°C for 48 h and weighted again. Petioles and leaf blades area were measured with WinRHIZO Pro 2009a software (Regent Instruments, Quebec, Canada). The dry weight of the leaf blades and petioles of the well-exposed leaves (DW_{b,we} resp. DW_{p,we}) were registered. The dry weight of the well-exposed leaves (DW_{leaf,we}) was calculated (Table 2). The leaf dry matter content (LDMC) was calculated by dividing the fresh biomass of the whole well-exposed leaves (petiole + leaf blade) by their dry biomass. The specific leaf area was calculated in two different ways. The specific leaf area with petiole (SLA) was calculated by dividing the whole leaf area (petiole + leaf blade) by its dry biomass. The specific leaf area without petiole (SLA_{b}) was calculated by dividing the leaf blade area by its dry biomass. Finally, the leaf nitrogen content (LNC) was determined by pooling the sampled well-exposed leaves of the four repetitions per species. LNC was determined as the total nitrogen content on a mass basis, measured according to Dumas method (CHN analyser, Elementar Vario Macro Cube).

A sample of leaves (petioles and leaf blades separately) was then collected on the whole plant to calculated specific leaf areas at the plant scale. To do so, petiole and leaf blade samples were weighed, scanned at 200 dots per inch and oven-dried for 48 h at 70°C. The specific leaf area with petiole at the plant scale (SLA_{ps}) was calculated by dividing the whole leaf area of the sample (petiole + leaf blade) by its dry biomass. The specific leaf area without petiole at the plant scale (SLA_{b,ps}) was calculated by dividing the leaf blade area of the sample by its dry biomass.

The rest of the plant was finally harvested and separated into stems, petioles and leaf blades. Each component was weighed separately, oven-dried for 48 h at 70°C and then weighted again. The leaf dry matter content at the plant scale (LDMC_{ps}) was calculated by dividing the total fresh biomass of the whole leaves (petiole + leaf blade, including the leaves used for SLAs determinations) by its dry biomass. The dry weight of the stems (DW_{s}), of the leaf blades (DW_{b}) and of the petioles (DW_{p}) (DW_{s} and DW_{p} including the leaves used for SLAs determinations) were registered. The total leaf blade area (LA), the leaf to soil ration (LSA), the leaf blade to petiole ratio (PBR), the total leaf dry weight (DW_{leaf}) and the aboveground dry biomass (BMa) were then calculated as described in Table 2. The aboveground leaf mass fraction with and without petioles (LMFa resp. LMFa_{b}) were calculated by dividing the leaf dry weight (DW_{leaf} resp. DW_{b}) by BMa. The aboveground leaf area ratio was calculated with and without petioles, on well-exposed leaves and at the plant scale (LAR_{a}, LAR_{a,b}, LAR_{a,ps}, LAR_{a,ps,b}) by multiplying the corresponding LMF and SLA (see Table 2 for the exact calculation formulas).

**Belowground measurements**

All measured variables are presented in Table 3.

Belowground traits were assessed, for each plant, in a 1-m deep and 1-m wide trench that was dug 20 cm from the base of the plant. The root intersections in the vertical soil profile were

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1 The rachis of compound leaves was considered as petiole and included in the “petiole” compartment. For monocots (except banana), leaves were cut at their insertion on the stem, without collecting leaf sheaths. As a consequence, “petiole” compartment is absent for monocots.

2 For monocots (except banana), SLA and SLA_{b} were considered equal (and as consequence LMFa and LMFa_{b}, LAR_{a} and LAR_{a,b}, LAR_{a,ps} and LAR_{a,b,ps}).
counted on a 5 cm × 5 cm mesh grid. The root impact density in soil layers explored by the roots were calculated as the number of root impacts observed divided by the surface of soil profile explored in this layer. For example, the root impact density in the 0–20 soil layer explored by the roots (RID_{0–20}) was calculated as the number of root intersections observed in this layer divided by the product of the height of the layer (20 cm) and the distance between the further root observed in this layer and the plant base. The root impact density in the 20–40, 40–60 and 60–80 soil layers explored by the roots (RID_{20–40}, RID_{40–60} and RID_{60–80}) were calculated similarly. The maximal rooting depth (RD_{max}) was determined by the deepest root intersection that was observed. The maximal rooting width (RW_{max}) was determined by the furthest root intersection that was observed from the plant base, whatever its depth. The median rooting depth (RD_{med}) was calculated as the depth at which 50% of the root intersections were observed.

For each plant, three cubes of 1000 cm³ of soil samples were removed: i) under the base of the plant at a depth of 0 to 10 cm, ii) under the base of the plant at a depth corresponding to half the maximum rooting depth, iii) at half the maximum rooting width and depth. Each sample was carefully washed to collect fine and coarse roots. The presence and activity of nodules (Nod) was assessed with a four-category variable (0: absence of nodules, 1: small white nodules, 2: medium size pink nodules, 3: large pink nodules). The roots were scanned at 400 dots per inch (scanner Epson expression 10000XL Pro-scanner). The length and diameter of each root sample were measured with WinRHIZO Pro 2009a software (Regent Instruments, Quebec, Canada). The mean root diameter (Diam) was calculated by averaging the diameters of the three samples per plant. The roots contained in the three soil samples were then pooled and weighed after drying for 72 h at 70°C. The specific root length (SRL) was calculated by dividing the total length of the roots in the three samples by their root dry biomass. The root length density (RLD) and the root weight density (RWD) were calculated by dividing, respectively, the total length and the total dry biomass of the roots in the three samples by the cumulated volume of these three samples (i.e. 3000 cm³).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

Acknowledgments

This experimental work was supported by the projects “AGROECOTROP” from E.U. FEDER. This valorization was supported by the project “TACOS” (ID 1702–014), which was publicly funded through ANR (the French National Research Agency) under the “Investissements d’avenir” programme with the reference ANR-10-LABX-001–01 Labex Agro and coordinated by Agropolis Foundation under the frame of I-SITE MUSE (ANR-16-IDEX-0006). The authors thank Charles Meynard, Mylène Ramassamy, Steewy Lakhia, Christina Racel, and Jean-Luc Jean-Louis for their technical support, and the laboratory “CIRAD US 49” for chemical analysis.

Author contributions

GD: Methodology, Supervision, Writing, Funding acquisition. FT: Methodology, Data acquisition, Data curation, Formal analysis. MD & DM: Methodology, Supervision, Funding acquisition.
Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.dib.2020.105890.

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