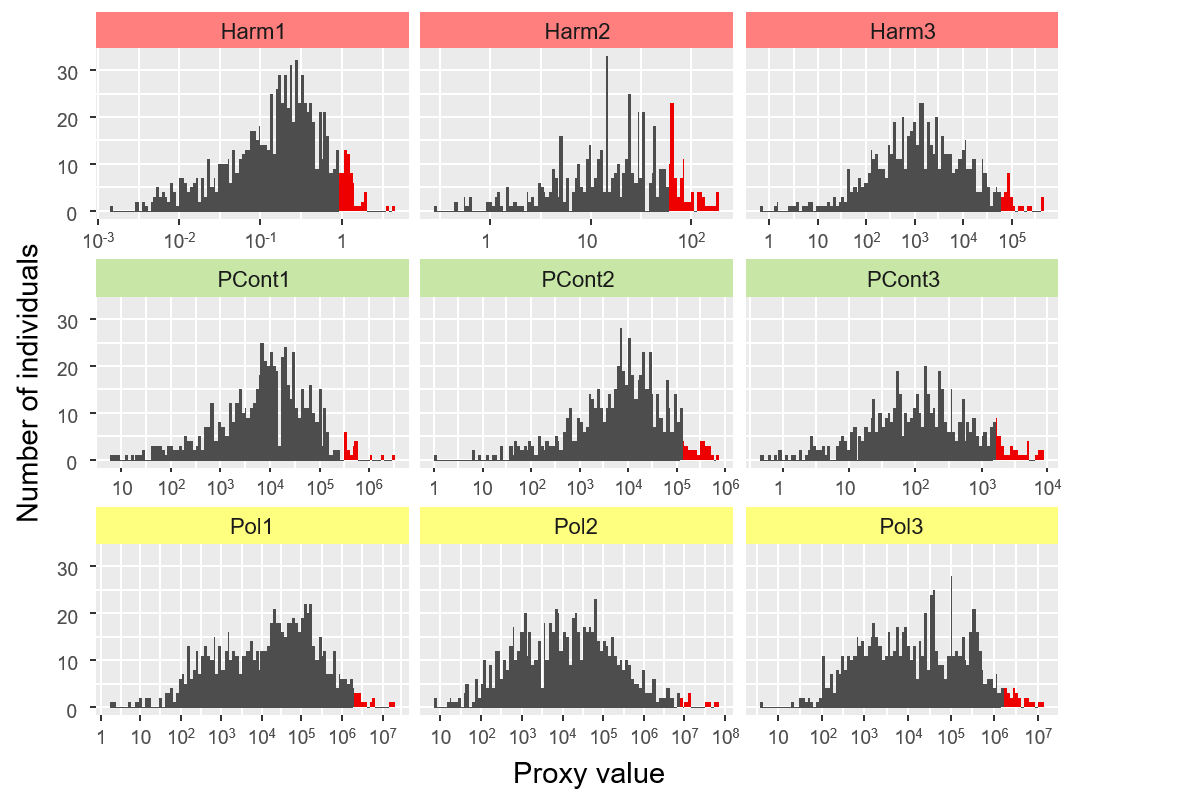
*Supplementary Materials*

**A framework to estimate the contribution of weeds to the delivery of ecosystem (dis)services in agricultural landscapes**

Séverin Yvoz, Stéphane Cordeau, Alexandre Ploteau, Sandrine Petit\*.

Agroécologie, AgroSup Dijon, INRAE, Univ. Bourgogne, Univ. Bourgogne Franche-Comté, F‑21000 Dijon, France

\* Corresponding author: sandrine.petit-michaut@inrae.fr; Tel. +33 3 80 69 30 32



**Supp. Figure 1**: Distribution of the values of the nine proxies (X axis: log10 scale) of the weed contribution to ecosystem services and harmfulness (detailed in Table 2) estimated at the plant level (N=967 individual situations, *i.e.* species by within-field location-by-crop type). Bars in red represent extreme values (*i.e.* higher than the median plus two standard deviations).

**Supp. Table 1**: Details of the weed traits and characteristics used to build the nine proxies of weed contribution to ecosystem services and harmfulness.

FloreAlpes: <https://www.florealpes.com/>

InfoFlora: <https://www.infoflora.ch/fr/>

TelaBotanica: <https://www.tela-botanica.org/>

eFlora: <https://ucjeps.berkeley.edu/eflora/>

| **Weed traits and characteristics** | **Type of data** | **Mean value [min-max]**  **or class** | **Comments** | **Sources** |
| --- | --- | --- | --- | --- |
| Corolla depth | Qualitative | <4.5 mm  >4.5 mm  No nectar or inaccessible | Missing value for 23 species | FloreAlpes |
| Ellenberg.L | Quantitative | 7.1 [4-9] | 7 values estimated at the genus level | (Julve, 1998) |
| Ellenberg.N | Quantitative | 6.2 [1-9] | 7 values estimated at the genus level | (Julve, 1998) |
| Flower class (Kuegler) | Qualitative | 28 classes | 3 values estimated at the genus level  Missing value for 2 species | (Klotz et al., 2002) |
| Flower colour | Qualitative | Brown, Red, Purple, Pink, White, Yellow, Green, Blue, Violet |  | (Klotz et al., 2002; Mamarot and Rodriguez, 2014; FloreAlpes, InfoFlora) |
| Flower diameter (mm) | Quantitative | 22.5 [1.5-160] |  | FloreAlpes  InfoFlora  TelaBotanica  eFlora |
| Flower shape | Qualitative | Capitulum, Corolla, Spikelet, Umbel, Catkin, Inflorescence |  | FloreAlpes  InfoFlora  TelaBotanica  eFlora |
| Flower symmetry | Qualitative | Actinomorphe, Zygomorphe,  No flower |  | (Klotz et al., 2002) |
| Flower type (Muller) | Qualitative | 17 classes | Missing value for 3 species | (Klotz et al., 2002) |
| Flowering onset and Flowering end | Quantitative | Month from 1 to 12, 1=January  5.1 [1-8]  8.9 [3-12] |  | (Mamarot and Rodriguez, 2014)  FloreAlpes  TelaBotanica |
| Germination period | Qualitative | Autumn, Autumn/(spring), Autumn/spring, Spring, Spring/summer, Summer, Indifferent | 4 values estimated at the genus level | (Mamarot and Rodriguez, 2014) |
| Height (cm) | Quantitative | 79 [15-250] |  | (Mamarot and Rodriguez, 2014)  TelaBotanica |
| Leaf dry matter content (LDMC) (mg/g) | Quantitative | 183 [84-408] | 8 values estimated at the genus level | (Kleyer et al., 2008) |
| Leaf type | Qualitative | Grass  Forb |  | (Klotz et al., 2002) |
| Nectar quality | Qualitative | None, Saccharose-dominant, Glucose/fructose-dominant, Balanced | 41 values estimated at the genus level  Missing value for 56 species | ([Percival, 1961](#_ENREF_6)) |
| Nectar quantity | Qualitative | None, Little, Present, Plenty | 17 values estimated at the genus level  Missing value for 4 species | ([Klotz et al., 2002](#_ENREF_3))  Internal Database |
| Pollen quantity | Qualitative | None, Plenty | 16 values estimated at the genus level  Missing value for 123 species | ([Klotz et al., 2002](#_ENREF_3)) |
| Pollen protein content (g/g) | Quantitative | 0.225 [0.131-0.466] | 50 values estimated at the genus level  Missing value for 92 species | ([Pamminger et al., 2019](#_ENREF_5); [Pernal and Currie, 2000](#_ENREF_7); [Radev, 2018](#_ENREF_8); [Somerville, 2001](#_ENREF_11)) |
| Pollinator value | Quantitative | Bees:  3.95 [1-7.49]  Bumblebees:  3.88 [1-8.65]  Hoverflies:  4.05 [1-8.78] | 12 values estimated at the genus level  Missing value for 22 species | ([Ricou et al., 2014](#_ENREF_9)) |
| Seed lipid content (g/g) | Quantitative | 0.18 [0-0.47] | 13 values estimated at the genus level  Missing value for 1 species | ([Bretagnolle et al., 2016](#_ENREF_1); [Matthäus, 2012](#_ENREF_4); [Royal Botanic Gardens Kew, 2020](#_ENREF_10)) |
| Seed longevity (year) | Qualitative | Transient = 1 year  Short-term = 3 years  Present = 5 years  Long-term = 10 years | 5 values estimated at the genus level | ([Kleyer et al., 2008](#_ENREF_2); [Tavşanoğlu and Pausas, 2018](#_ENREF_12)) |
| Seed mass (mg) | Quantitative | 2.81 [0.01-33.5] | Missing value for 1 species | ([Royal Botanic Gardens Kew, 2020](#_ENREF_10)) |
| Specific leaf area (SLA) (mm²/mg) | Quantitative | 25.2 [8.6-65.1] | 8 values estimated at the genus level | ([Kleyer et al., 2008](#_ENREF_2)) |
| UV-reflectance in flower centre (%) | Quantitative | 8.1 [3.5-53] | 35 values estimated at the genus level  Missing value for 14 species | ([Klotz et al., 2002](#_ENREF_3)) |
| UV-reflectance in flower petals (%) | Quantitative | 19.2 [3.5-92.5] | 37 values estimated at the genus level  Missing value for 9 species | ([Klotz et al., 2002](#_ENREF_3)) |

**Supp. Table 2**: Coefficient of germination period synchrony based on the germination periods of weed species and crop types.

|  |  |  |
| --- | --- | --- |
| **Crop germination period** | **Weed germination period** | **Coefficient of synchrony** |
| **Winter wheat, barley and pea**  Sowing period: October-November  Germination period: Autumn | Autumn  Autumn/(spring)  Autumn/spring  Spring  Spring/(summer)  Summer  Indifferent | 1  1  0.8  0.4  0.2  0.1  0.5 |
| **Winter oilseed rape and mustard**  Sowing period: September  Germination period: Autumn | Autumn  Autumn/(spring)  Autumn/spring  Spring  Spring/(summer)  Summer  Indifferent | 1  1  0.7  0.2  0.1  0.1  0.5 |
| **Spring barley, wheat, mustard and pea**  Sowing period: February-March  Germination period: Spring | Autumn  Autumn/(spring)  Autumn/spring  Spring  Spring/(summer)  Summer  Indifferent | 0.4  0.8  1  0.8  0.4  0.1  0.5 |
| **Sunflower**  Sowing period: April  Germination period: Spring/(summer) | Autumn  Autumn/(spring)  Autumn/spring  Spring  Spring/(summer)  Summer  Indifferent | 0.1  0.1  0.3  1  1  0.8  0.5 |
| **Maize and soybean**  Sowing period: April-May  Germination period: Summer | Autumn  Autumn/(spring)  Autumn/spring  Spring  Spring/(summer)  Summer  Indifferent | 0.1  0.1  0.3  0.8  1  1  0.5 |

**Supp. Table 3**: Coefficient of synchrony between the flowering period of the weed species and either the flowering (for Harm1 computation, called FP in the equation provided in Table 2) or harvesting (for Harm2 computation, called S in the equation provided in Table 2) period of the crop.

|  |  |
| --- | --- |
| **Relative difference between weed and crop flowering periods** | **Coefficient of synchrony FP used for Harm1 computation** |
| The weed flowering period starts the same month or one month earlier than the crop flowering onset | 1 |
| The weed flowering starts two months earlier than the crop flowering onset | 0.7 |
| The weed ends flowering one month later than the crop flowering onset | 0.7 |
| The weed flowering starts three months (or more) earlier than the crop flowering onset | 0.3 |
| The weed ends flowering two months later than the crop flowering onset | 0.3 |
| The weed ends flowering three months (or more) later than the crop flowering onset | 0.1 |
| **Relative difference between weed flowering and crop harvest periods** | **Coefficient of synchrony S used for Harm2 computation** |
| The weed flowering period starts the same month or one month earlier than the crop harvest | 1 |
| The weed flowering starts two months earlier than the crop harvest | 0.7 |
| The weed ends flowering one month later than the crop harvest | 0.7 |
| The weed flowering starts three months (or more) earlier than the crop harvest | 0.3 |
| The weed ends flowering two months later than the crop harvest | 0.3 |
| The weed ends flowering three months (or more) later than the crop harvest | 0.1 |

**Supp. Table 4**: Associations between the 155 weed species and the five identified proxy bundles (PB) depending on the 12 combinations of within-field location-by-crop type. Species are named by their EPPO codes (<https://www.eppo.int/>)

|  |  | **Winter wheat** | | **Winter oilseed rape** | | **Winter mustard** | | **Winter barley** | | **Spring barley** | | **Soybean** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Weed species** | **Number of PBs** | **Field edge** | **Field core** | **Field edge** | **Field core** | **Field edge** | **Field core** | **Field edge** | **Field core** | **Field edge** | **Field core** | **Field edge** | **Field core** | |
| LAMPU | 1 | PB5 |  | PB5 |  | PB5 |  | PB5 |  | PB5 |  |  |  | |
| PICEC | 1 | PB5 |  | PB5 |  | PB5 |  |  |  | PB5 |  |  |  | |
| CVPSS | 1 | PB5 |  | PB5 |  | PB5 |  |  |  |  |  |  |  | |
| EHIVU | 1 | PB5 |  | PB5 |  |  |  |  |  | PB5 |  |  |  | |
| THLAR | 1 |  |  | PB5 |  |  |  | PB5 |  |  |  |  |  | |
| THLPE | 1 |  |  | PB5 |  | PB5 |  |  |  |  |  |  |  | |
| KNAAR | 1 | PB5 |  |  |  |  |  |  |  |  |  |  |  | |
| TROSPP | 1 | PB5 |  |  |  |  |  |  |  |  |  |  |  | |
| BARSPP | 1 |  |  |  |  | PB5 |  |  |  |  |  |  |  | |
| SENVI | 1 |  |  |  |  |  |  |  |  |  |  |  | PB5 | |
| EPHHE | 1 | PB3 | PB3 | PB3 | PB3 | PB3 | PB3 | PB3 | PB3 | PB3 |  | PB3 | PB3 | |
| TRFRE | 1 | PB3 |  | PB3 | PB3 | PB3 | PB3 | PB3 |  |  |  |  |  | |
| CZRVA | 1 | PB3 |  | PB3 |  | PB3 |  | PB3 |  | PB3 |  | PB3 |  | |
| CERSPP | 1 | PB3 |  | PB3 |  | PB3 |  | PB3 |  | PB3 |  |  |  | |
| CNSRE | 1 | PB3 |  |  |  | PB3 |  | PB3 |  | PB3 |  |  |  | |
| HOLMO | 1 | PB3 | PB3 | PB3 | PB3 |  |  |  |  |  |  |  |  | |
| SAWOF | 1 | PB3 |  | PB3 |  |  |  |  |  |  |  |  |  | |
| CARHI | 1 |  |  | PB3 |  | PB3 |  |  |  |  |  |  |  | |
| ANRCA | 1 | PB3 |  |  |  |  |  |  |  |  |  |  |  | |
| PLAME | 1 | PB3 |  |  |  |  |  |  |  |  |  |  |  | |
| SXFTR | 1 | PB3 |  |  |  |  |  |  |  |  |  |  |  | |
| TUSFA | 1 | PB3 |  |  |  |  |  |  |  |  |  |  |  | |
| EPHFA | 1 |  |  | PB3 |  |  |  |  |  |  |  |  |  | |
| EPHPE | 1 |  |  | PB3 |  |  |  |  |  |  |  |  |  | |
| SANMI | 1 |  |  | PB3 |  |  |  |  |  |  |  |  |  | |
| OXASS | 1 |  |  |  |  |  |  | PB3 |  |  |  |  |  | |
| TRFCA | 1 |  |  |  |  |  |  |  |  |  |  |  | PB3 | |
| AMIMA | 1 |  |  |  |  |  |  |  |  |  |  | PB4 | PB4 | |
| SETVI | 1 |  |  |  |  |  |  |  |  |  |  | PB4 | PB4 | |
| CLVVT | 1 | PB4 |  |  |  |  |  |  |  |  |  |  |  | |
| SLYMA | 1 |  |  | PB4 |  |  |  |  |  |  |  |  |  | |
| ARREL | 1 |  |  |  |  |  |  | PB4 |  |  |  |  |  | |
| ALLSS | 1 | PB2 |  | PB2 | PB2 | PB2 | PB2 | PB2 |  | PB2 |  |  |  | |
| AGIEU | 1 | PB2 |  |  |  | PB2 |  |  |  |  |  |  |  | |
| VEBOF | 1 |  |  |  |  | PB2 |  | PB2 |  |  |  |  |  | |
| HMAHI | 1 | PB2 |  |  |  |  |  |  |  |  |  |  |  | |
| ERISU | 1 |  |  |  |  | PB2 |  |  |  |  |  |  |  | |
| EQUAR | 1 | PB1 | PB1 | PB1 | PB1 | PB1 | PB1 | PB1 | PB1 | PB1 | PB1 | PB1 | PB1 | |
| GERRO | 1 |  |  |  |  |  |  |  |  | PB1 |  |  |  | |
| VERHE | 2 | PB5 | PB5 | PB5 | PB5 | PB5 | PB5 | PB5 | PB5 | PB5 | PB1 |  |  | |
| EROCI | 2 | PB5 |  | PB5 | PB5 | PB5 | PB5 | PB5 |  | PB5 | PB1 | PB5 |  | |
| GERCO | 2 | PB5 |  | PB5 | PB5 | PB5 |  | PB5 | PB3 | PB5 |  |  |  | |
| SENVU | 2 | PB5 | PB5 | PB5 | PB5 | PB5 | PB5 | PB5 | PB1 | PB5 | PB1 | PB5 | PB5 | |
| VICSA | 2 | PB5 | PB2 | PB5 | PB5 | PB5 |  | PB5 |  |  |  |  |  | |
| GERPU | 2 | PB5 | PB3 | PB5 | PB5 | PB5 | PB5 | PB5 |  | PB3 |  | PB5 | PB5 | |
| VERPE | 2 | PB5 | PB3 | PB5 | PB5 | PB5 | PB5 | PB5 | PB3 | PB5 | PB3 | PB5 | PB5 | |
| MATSPP | 2 | PB5 | PB1 | PB5 | PB5 | PB5 | PB1 | PB5 | PB5 | PB5 | PB1 | PB5 | PB5 | |
| PTLAN | 2 | PB2 |  | PB5 |  |  |  |  |  | PB5 |  | PB5 |  | |
| LAMAM | 2 | PB5 | PB3 | PB5 |  | PB5 | PB5 | PB5 |  | PB3 |  |  |  | |
| GALMO | 2 | PB4 |  | PB5 |  | PB5 |  | PB4 |  | PB5 |  | PB5 |  | |
| ARBTH | 2 |  |  | PB3 |  | PB5 | PB5 |  |  |  |  |  |  | |
| RUMOB | 2 |  | PB1 | PB5 | PB5 |  |  |  |  |  |  |  |  | |
| VERAR | 2 | PB5 | PB3 | PB5 | PB5 | PB5 |  | PB5 | PB3 | PB3 |  |  |  | |
| RUBSS | 2 | PB2 |  | PB5 |  | PB2 |  | PB2 |  | PB5 |  | PB5 |  | |
| COPSQ | 2 | PB3 |  |  |  | PB5 |  |  |  | PB5 |  | PB3 |  | |
| RAPRA | 2 |  |  |  |  |  |  |  |  | PB5 | PB2 |  |  | |
| VERPO | 2 | PB3 | PB3 | PB5 | PB3 | PB5 | PB5 | PB3 | PB3 | PB3 |  |  |  | |
| ACHMI | 2 | PB5 |  | PB2 |  | PB2 |  | PB2 |  | PB2 |  | PB5 |  | |
| ERXCA | 2 | PB3 |  |  |  |  |  | PB3 |  |  |  | PB5 |  | |
| VIOSS | 2 | PB3 | PB3 | PB3 | PB3 | PB3 | PB3 | PB3 | PB2 | PB3 | PB2 | PB3 | PB3 | |
| AGSST | 2 | PB3 |  | PB2 |  | PB3 |  | PB3 |  | PB3 |  |  |  | |
| POAAN | 2 | PB3 |  | PB3 |  | PB3 |  | PB3 |  | PB2 |  |  |  | |
| GLEHE | 2 | PB3 |  | PB3 |  | PB3 |  | PB3 |  |  |  | PB1 |  | |
| TRFPR | 2 | PB3 | PB3 |  | PB3 | PB3 | PB3 | PB1 |  | PB3 | PB1 |  |  | |
| ATHOR | 2 |  |  |  |  | PB3 | PB3 |  | PB1 |  |  |  |  | |
| SHRAR | 2 | PB1 |  |  |  | PB3 |  | PB3 |  |  |  |  |  | |
| BROSPP | 2 | PB4 | PB4 | PB3 | PB3 | PB3 | PB3 | PB4 |  | PB4 |  | PB3 | PB3 | |
| EPHPL | 2 |  |  | PB3 |  | PB2 | PB3 | PB2 |  | PB3 |  |  |  | |
| LOLSS | 2 | PB4 | PB3 | PB3 | PB3 | PB3 | PB3 | PB4 | PB3 | PB4 |  | PB4 | PB4 | |
| PLALA | 2 | PB3 | PB3 | PB1 | PB3 | PB1 | PB3 | PB3 |  | PB1 | PB1 | PB3 | PB1 | |
| ALOMY | 2 | PB4 | PB3 | PB3 | PB4 | PB3 | PB3 | PB4 | PB4 | PB4 | PB4 | PB3 | PB3 | |
| AVEFA | 2 | PB4 |  | PB4 | PB4 |  | PB3 |  |  |  |  | PB3 | PB3 | |
| EPIAD | 2 | PB3 |  |  |  | PB2 |  |  |  |  |  |  |  | |
| AMBEL | 2 | PB3 |  |  |  | PB1 |  |  |  |  |  |  |  | |
| STAAN | 2 | PB3 |  |  |  |  | PB1 |  |  |  |  |  |  | |
| HYPPE | 2 | PB2 |  | PB3 |  | PB2 |  | PB2 |  |  |  |  |  | |
| DACGL | 2 | PB4 |  | PB3 |  | PB4 |  | PB4 |  | PB4 |  | PB4 |  | |
| SETPU | 2 |  |  |  |  |  |  |  |  | PB2 |  | PB4 | PB4 | |
| ARFLA | 2 | PB2 |  |  |  |  |  |  |  |  |  | PB4 |  | |
| POLAM | 2 | PB2 |  |  |  |  |  |  |  |  |  | PB4 |  | |
| AMASS | 2 |  |  |  | PB1 |  |  |  |  | PB1 | PB1 | PB4 | PB4 | |
| CHEPO | 2 | PB2 | PB1 |  |  | PB2 | PB2 | PB2 |  |  |  |  |  | |
| ERPVE | 2 | PB2 | PB1 | PB2 | PB2 | PB2 |  |  |  |  |  |  |  | |
| CENSC | 2 | PB1 |  | PB2 |  | PB2 |  |  |  | PB2 |  |  |  | |
| CENJA | 2 | PB1 |  | PB2 |  | PB2 |  |  |  |  |  |  |  | |
| MENSU | 2 |  |  |  |  |  | PB1 |  |  | PB2 |  |  |  | |
| DIWSI | 2 | PB1 |  |  |  | PB2 |  |  |  | PB1 |  |  |  | |
| GERRT | 3 | PB5 | PB5 | PB5 | PB5 | PB5 | PB5 | PB5 | PB3 | PB1 |  | PB5 | PB5 | |
| CAPBP | 3 | PB1 | PB5 | PB5 | PB5 | PB5 | PB5 | PB2 |  | PB5 | PB5 | PB5 | PB5 | |
| STEME | 3 | PB5 | PB5 | PB5 |  | PB5 |  | PB4 |  | PB5 | PB3 |  |  | |
| CENCY | 3 | PB5 | PB5 | PB5 | PB5 | PB5 | PB5 | PB1 | PB1 | PB5 |  | PB2 |  | |
| GERDI | 3 | PB5 | PB3 | PB5 | PB5 | PB5 | PB5 | PB5 | PB3 | PB3 | PB1 | PB5 | PB5 | |
| RESLU | 3 | PB5 | PB1 | PB3 | PB5 | PB5 |  | PB5 |  | PB5 |  | PB5 | PB1 | |
| GERMO | 3 | PB5 | PB5 | PB5 |  | PB5 |  | PB3 |  | PB1 |  |  |  | |
| LEGSPP | 3 | PB5 |  | PB3 | PB5 | PB5 |  |  | PB2 |  |  |  |  | |
| LINVU | 3 | PB5 |  |  |  | PB2 |  | PB5 |  | PB1 |  | PB5 |  | |
| FUMOF | 3 | PB3 | PB3 | PB5 | PB5 | PB5 | PB5 | PB5 | PB1 | PB3 | PB1 | PB5 |  | |
| SINAR | 3 | PB1 | PB1 | PB5 | PB5 | PB5 | PB5 | PB5 | PB1 | PB5 | PB1 | PB4 | PB4 | |
| SILVU | 3 | PB5 | PB1 | PB3 |  | PB5 |  | PB5 | PB3 | PB5 |  | PB3 |  | |
| LITAR | 3 | PB5 | PB1 | PB5 |  | PB5 |  | PB3 |  | PB3 |  |  |  | |
| ANTAR | 3 | PB5 |  | PB2 |  | PB2 | PB5 | PB5 |  | PB1 |  |  |  | |
| TAROF | 3 | PB3 | PB3 | PB5 | PB5 | PB5 | PB3 | PB5 | PB1 | PB5 | PB1 | PB3 | PB1 | |
| PTLRE | 3 | PB2 |  | PB3 |  | PB2 |  | PB2 |  | PB5 |  | PB5 |  | |
| PICHI | 3 | PB5 |  | PB1 | PB5 | PB2 | PB1 | PB2 |  | PB1 |  | PB1 |  | |
| SONOL | 3 |  |  | PB5 |  |  |  | PB4 |  |  |  | PB4 | PB1 | |
| LACSE | 3 | PB1 |  | PB1 | PB5 | PB2 | PB1 | PB1 |  |  |  | PB1 |  | |
| MEDSPP | 3 | PB3 | PB1 | PB3 | PB3 | PB3 | PB3 | PB3 |  |  |  | PB2 |  | |
| ANGAR | 3 | PB3 | PB1 | PB3 | PB2 | PB3 | PB3 | PB2 | PB1 | PB3 | PB3 | PB3 | PB3 | |
| ARTVU | 3 | PB3 |  | PB2 |  | PB3 |  |  |  | PB3 |  | PB4 |  | |
| CRXSS | 3 | PB2 |  | PB3 |  | PB3 |  | PB3 |  |  |  | PB1 |  | |
| AGRRE | 3 | PB4 |  | PB2 | PB3 | PB3 | PB3 | PB2 | PB3 | PB4 | PB3 | PB4 | PB3 | |
| MERAN | 3 | PB1 | PB1 | PB3 | PB3 | PB3 | PB3 | PB3 | PB1 | PB3 | PB1 | PB4 | PB4 | |
| RUMCR | 3 | PB3 | PB1 | PB3 | PB3 | PB1 |  | PB3 |  | PB1 |  | PB4 |  | |
| PLAMA | 3 | PB3 |  | PB2 | PB3 | PB2 |  | PB3 |  | PB1 |  |  |  | |
| POATR | 3 | PB4 |  | PB3 |  | PB4 | PB3 | PB4 |  | PB2 |  | PB3 |  | |
| GALAP | 3 | PB4 | PB3 | PB3 | PB3 | PB4 | PB1 | PB4 | PB4 | PB4 | PB1 | PB3 | PB3 | |
| APHAR | 3 | PB3 | PB3 | PB3 | PB1 | PB2 | PB1 | PB2 | PB2 |  |  |  |  | |
| URTDI | 3 | PB4 |  | PB3 |  | PB1 |  | PB1 |  |  |  |  |  | |
| CAGSE | 3 | PB2 |  |  | PB1 |  |  | PB4 |  |  |  | PB4 | PB4 | |
| CHEHY | 3 |  | PB1 |  | PB2 |  |  |  |  |  |  | PB4 | PB4 | |
| ECHCG | 3 |  |  |  | PB1 |  | PB2 |  |  | PB2 | PB2 | PB4 | PB4 | |
| BIDTR | 3 | PB2 | PB1 |  |  | PB2 |  |  |  |  | PB1 | PB4 | PB4 | |
| MALSI | 3 | PB2 |  |  | PB1 |  |  |  |  |  |  | PB4 |  | |
| POLCO | 3 | PB2 | PB2 | PB2 | PB2 | PB2 | PB2 | PB2 | PB2 | PB2 | PB1 | PB4 | PB4 | |
| CONAR | 3 | PB2 | PB1 | PB2 | PB1 | PB2 | PB2 | PB2 | PB1 | PB2 | PB2 | PB4 | PB4 | |
| POLAV | 3 | PB2 | PB1 | PB2 | PB2 | PB2 | PB1 | PB2 | PB1 | PB2 | PB1 | PB4 | PB4 | |
| POLLA | 3 | PB2 | PB1 | PB1 | PB2 | PB2 | PB2 | PB2 | PB1 | PB1 | PB2 | PB4 | PB4 | |
| CHEAL | 3 | PB2 | PB1 | PB1 | PB2 | PB2 | PB2 | PB2 | PB1 | PB1 | PB1 | PB4 | PB4 | |
| PAVSA | 3 | PB1 |  | PB1 |  | PB1 |  | PB2 | PB1 | PB1 | PB1 | PB1 | PB4 | |
| ATXPA | 3 | PB2 | PB1 | PB1 | PB2 | PB1 | PB2 | PB1 | PB1 | PB1 | PB1 | PB4 |  | |
| SOLNI | 3 | PB1 | PB1 | PB1 | PB2 | PB2 | PB2 | PB2 | PB1 | PB1 | PB1 | PB2 | PB4 | |
| MYOAR | 4 | PB5 |  | PB3 | PB5 | PB5 | PB5 | PB5 | PB2 | PB5 | PB1 |  |  | |
| SCAPV | 4 | PB3 | PB1 | PB5 | PB5 | PB5 |  | PB5 | PB3 | PB5 |  | PB2 |  | |
| SONAS | 4 | PB5 | PB1 | PB5 | PB5 | PB5 | PB5 | PB2 |  | PB1 | PB1 | PB4 | PB4 | |
| CHNMI | 4 | PB3 |  |  |  | PB2 | PB1 |  |  | PB3 | PB1 | PB5 | PB5 | |
| RANRE | 4 | PB5 |  | PB2 |  |  |  | PB3 |  | PB1 |  |  |  | |
| ARISE | 4 | PB2 | PB1 | PB2 |  | PB5 |  | PB3 |  |  |  |  |  | |
| LAPCO | 4 | PB4 | PB2 | PB5 | PB5 | PB4 |  | PB2 | PB1 | PB4 | PB1 | PB4 | PB4 | |
| CIRVU | 4 | PB1 | PB1 | PB1 | PB3 | PB2 | PB1 | PB1 |  | PB1 |  | PB1 | PB5 | |
| EPHEX | 4 | PB1 | PB1 | PB3 | PB5 | PB3 | PB3 | PB2 | PB1 | PB3 | PB3 | PB3 | PB3 | |
| SONAR | 4 | PB3 | PB3 | PB2 |  |  | PB1 |  |  |  |  |  | PB4 | |
| PAPRH | 4 | PB4 | PB3 | PB4 | PB3 | PB4 | PB3 | PB4 | PB2 | PB4 | PB1 | PB3 |  | |
| POAPR | 4 | PB2 |  | PB1 |  | PB2 | PB3 | PB2 |  | PB4 |  | PB3 |  | |
| CIRAR | 4 | PB3 | PB3 | PB2 | PB1 | PB1 | PB1 | PB3 | PB1 | PB1 | PB1 | PB4 | PB4 | |
| FESSPP | 4 | PB2 | PB1 | PB3 |  | PB2 | PB1 | PB2 |  | PB4 |  | PB3 |  | |
| LTHTU | 4 | PB1 | PB1 | PB3 | PB3 | PB2 |  | PB1 |  | PB2 |  | PB4 | PB4 | |
| MELAL | 4 | PB4 | PB1 | PB3 | PB1 | PB3 | PB1 | PB2 |  | PB4 |  | PB4 | PB4 | |
| SAMEB | 4 | PB3 |  | PB2 |  | PB1 |  |  |  | PB1 |  | PB4 | PB4 | |
| POLPE | 4 |  | PB1 |  | PB2 | PB2 | PB2 |  |  | PB1 |  | PB3 | PB4 | |
| AETCY | 4 | PB1 | PB1 | PB2 | PB2 | PB3 | PB1 | PB1 | PB1 | PB1 | PB1 | PB4 | PB1 | |
| TOISPP | 5 | PB4 | PB3 | PB5 |  | PB5 | PB5 | PB1 |  |  |  | PB2 |  | |
| VLLSS | 5 | PB3 | PB1 | PB3 | PB3 | PB5 |  | PB4 | PB2 |  |  |  |  | |
| HERSP | 5 | PB1 |  | PB5 |  | PB3 |  | PB1 | PB1 | PB2 |  | PB4 |  | |
| KICSP | 5 | PB3 |  | PB3 | PB2 | PB2 | PB1 | PB2 |  | PB3 | PB1 | PB4 | PB5 | |
| DAUCA | 5 | PB3 | PB1 | PB5 | PB3 | PB3 | PB1 | PB1 | PB1 | PB2 |  | PB4 | PB4 | |

References

Julve, P.H., 1998. Baseflor. Index botanique, écologique et chorologique de la flore de France [WWW Document]. Inst. Cathol. Lille Lille. URL http://philippe.julve.pagesperso-orange.fr/catminat.htm (accessed 4.16.20).

Kleyer, M., Bekker, R.M., Knevel, I.C., Bakker, J.P., Thompson, K., Sonnenschein, M., Poschlod, P., Van Groenendael, J.M., Klimeš, L., Klimešová, J., 2008. The LEDA Traitbase: a database of life‐history traits of the Northwest European flora. J. Ecol. 96, 1266–1274. https://doi.org/10.1111/j.1365-2745.2008.01430.x

Klotz, S., Kühn, I., Durka, W., 2002. BIOLFLOR - Eine Datenbank zu biologisch-ökologischen Merkmalen der Gefäßpflanzen in Deutschland. - Schriftenreihe für Vegetationskunde 38. Bonn: Bundesamt für Naturschutz.

Mamarot, J., Rodriguez, A., 2014. Mauvaises herbes des cultures. Acta, le réseau des Instituts des Filières Animales et Végétales.

Pamminger, T., Becker, R., Himmelreich, S., Schneider, C.W., Bergtold, M., 2019. Pollen report: quantitative review of pollen crude protein concentrations offered by bee pollinated flowers in agricultural and non-agricultural landscapes. PeerJ 7, e7394. https://doi.org/10.7717/peerj.7394

Pernal, S.F., Currie, R.W., 2000. Pollen quality of fresh and 1-year-old single pollen diets for worker honey bees (Apis mellifera L.). Apidologie 31, 387–409. https://doi.org/10.1051/apido:2000130

Radev, Z., 2018. The impact of different protein content of pollen on honey Bee (Apis mellifera L.) development. Am. J. Entomol. 2, 23. https://doi.org/10.11648/j.aje.20180203.11

Somerville, D., 2001. Nutritional value of bee collected pollens: a report for the Rural Industries Research and Development Corporation. RIRDC, Barton, A.C.T.