**SUPPLEMENTAL MATERIAL FOR**

**A multi-criteria evaluation of fall vegetation services and dis-services in 30 cropping systems varying in cover crop system, tillage and residue management**

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**Supplemental Table S1**. Product and active ingredients in each herbicide package applied and each component’s assigned Danish Pesticide Load (a function of both the active ingredient and the amount applied)

|  |  |  |  |
| --- | --- | --- | --- |
| **Herbicide Package (HP)** | **Product name and application amount** | **Active ingredient name, CAS identification number, and application amount** | **Pesticide Load Indice** |
| HP1 | 2.1 L ha-1 Roundup Flex XXL | 1000 g ha-1 glyphosate; CAS 1071-83-6 |  |
| HP2 | 2.5 L ha-1 Roundup Flex XXL | 1200 g ha-1 glyphosate; CAS 1071-83-6 |  |
| HP3 | 12 g ha-1 Harmony SX + | 6 g ha-1 thifensulfuron-methyl; CAS 79277-27-3 |  |
|  | 0.15 L ha-1 Agropol (a surfactant) | - | 0 |
| HP4 | 0.25 L ha-1 Starane 333 HL plus | 83 g ha-1 fluroxypyr (CAS 69377-81-7) |  |
|  | 0.03 L ha-1 Hussar OD | 3 g ha-1 mefenpyr-diethyl (CAS 135590-91-9) and 1 g ha-1 iodosulfuron-methyl-Na (CAS 144550-36-7) |  |
|  | 0.5 L ha-1 Renol (a penetrating oil) | - |  |
| HP5 | 1 L ha-1 Metaxone | 750 g ha-1 MCPA (CAS 94-74-6) |  |
| HP6 | 0.5 L ha-1 Starane XL | 90 g ha-1 Fluroxypyr (CAS 69377-81-7) |  |
|  | 10 g ha-1 Trimmer SG | 5 g ha-1 tribenuron-methyl (CAS 101200-48-0) |  |
|  | 0.15 L ha-1 Agropol (a surfactant) | - |  |
| HP7 | 0.5 L ha-1 Stomp CS | 228 g ha-1 pendimethalin (CAS 40487-42-1) |  |
|  | 0.4 L ha-1 Fighter 480 | 192 g ha-1 bentazone (CAS 25057-89-0) |  |
| HP8 | 0.93 L ha-1Agil 100 EC | 93 g ha-1 propaquizafop (CAS 111479-05-1) |  |

**Supplemental Table S2.** Summary of the indices derived from Yvoz et al. 2021 used in the present study. The reader is directed to the publication for more information.

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Sub-indice** | **Description** | **Components, in brief** |
| Potential benefit to pollinators | Pol1 | Benefit to bees | Value to pollinators group (Table 3 from (Ricou et al., 2014)) flower diameter, average number of flowers per plant |
| Pol2 | Benefit to bumble bees | Same as above |
| Pol3 | Benefit to hoverflies | Same as above |
| Potential contribution to organisms | Cont1 | Contribution to farmland birds | Seed lipid content, seed mass, average number of seeds per plant |
| Cont2 | Contribution to carabids | Seed lipid content, seed mass, seed accessibility (size), average number of seeds per plant |
| Cont3 | Contribution to parasitoid wasps | Nectar quantity, flower form, corolla depth, flower number, extra floral nectar production |
| Potential agronomic harm | Harm1 | Competition with crop | Germination period, flowering period, relative height, relative Ellenberg N, relative specific leaf area, survival success in crop |
| Harm2 | Contribution to harvest difficulties | Maximum height, proportion of plants green at harvest, synchrony between flowering period and crop harvest |
| Harm3 | Contribution to future weed infestations | Seed longevity, average seed number per plant |

# Calculating aggregate, scaled values

Individual species values were calculated as described in the main text. Resulting values are presented in Table S3.

**Supplementary Table S3.** Service and dis-service scores assigned to individual species or genuses found in this study, derived from data presented in Yvoz et al. 2021

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **EPPO code** | **Latin name** | **Ecosystem contribution\*** | **Pollinator\* support** | **Benefit\*\*** | **Harm\*** | ***Net value\*\*\**** |
| AVESA | Avena sativa | 0 | 0 | 0 | 0 | *0* |
| CAPBP | Capsella bursa-pastoris | 2.89 | 2.06 | 2.89 | 1.53 | *1.36* |
| CIRAR | Cirsium arvense | 0.5 | 1.62 | 1.62 | 2.75 | *-1.12* |
| EPHEX | Euphorbiaceae | 0.16 | 0.13 | 0.16 | 0.17 | *-0.01* |
| GERSS | Geranium species | 1.1 | 1.44 | 1.44 | 0.54 | *0.9* |
| HORVW | Hordeum vulgare | 0 | 0 | 0 | 0 | *0* |
| LAMSS | Lamium species | 0.16 | 0.2 | 0.2 | 0.24 | *-0.04* |
| LOLPE | Lolium perenne | 0 | 0 | 0 | 0 | *0* |
| MATIN | Tripleurospermum inodorum | 0 | 0 | 0 | 0 | *0* |
| PAPRH | Papaver rhoeas | 2 | 0.76 | 2 | 2.34 | *-0.34* |
| RAPSR | Raphanus sativus | 0 | 0 | 0 | 0 | *0* |
| SENSS | Senecio species | 0.6 | 1.15 | 1.15 | 1.19 | *-0.04* |
| soil | - | 0 | 0 | 0 | 0 | *0* |
| TAROF | Taraxacum officinale | 0.16 | 1.18 | 1.18 | 0.12 | *1.07* |
| TRFRE | Trifolium repens | 0.1 | 1.3 | 1.3 | 0.56 | *0.74* |
| VERSS | Veronica species | 0.4 | 1.54 | 1.54 | 0.33 | *1.21* |

*\*The maximum possible value is 3*

*\*\*Benefit is the maximum value of Ecosystem contribution and Pollinator support values*

*\*\*\*Presented only to help interpretation, this value was not used in any subsequent calculations*

# Calculating community metrics

## Potential benefit

The potential benefit provided by the fall vegetation community was calculated by weighting each species/genus value by its respective percent cover contribution in a given sample. The mean community values for ‘Benefit’ were calculated for each tillage, cover crop, and residue treatment across years. The resulting values were scaled from 0-1 with 0 representing the lowest observed community ‘Benefit’ value (0, several systems), and 1 representing the maximum observed community ‘Benefit’ value (0.67 in the notill/mixE/-res).

## Potential harm

The same procedure was used for assigning potential Harm to each fall vegetation community.

## Yield

The total grain yields for each tillage, cover crop, and residue combination were summed to get a total yield accrued over the three years. These values were then scaled from 0 to 1 with 0 representing the lowest observed cumulative grain yield (12.5 in the notill/mixE/-res), 1 representing the highest (13.1 in the noninv/radM/-res).

## Fall biomass

The biomass for each tillage, cover crop, and residue combination in a given year were summed to get a total biomass produced over the three years. These values were then scaled from 0 to 1 with 0 representing the lowest observed cumulative biomass production (226 in the inv/radL/-res) and 1 representing the highest (552 in the notill/radM/+res).

## Pesticide toxicity load

The pesticide load index for each tillage, cover crop, and residue combination was summed over the three years. The values were then scaled from 0 to 1, with 0 as the lowest observed pesticide load (0.272 in the inv/mixE) and 1 as the highest observed pesticide load (1.48, several systems).

## Perennial weed legacy

The average spring counts of perennial weeds (CIRAR, EQUAR) were summed over the two samplings for each tillage, cover crop, and residue treatment. The values were then scaled from 0 to 1, with 0 as the lowest observed cumulative count (0, several systems) and 1 as the highest observed cumulative count (110, notill/mixE/-res).