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Ewald Weber, Daniel Gut

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# A survey of weeds that are increasingly spreading in Europe

Ewald WEBER<sup>a,b\*</sup>, Daniel GUT<sup>a</sup>

<sup>a</sup> Swiss Federal Research Station of Fruit-Growing, Viticulture and Horticulture, 8820 Wädenswil, Switzerland

<sup>b</sup> Swiss Federal Institute of Technology, Geobotanical Institute, Zürichbergstrasse 38, 8044 Zurich, Switzerland

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**Abstract** – A Europe-wide survey was conducted by sending questionnaires to weed scientists in order to evaluate currently troublesome weeds and those which may cause problems in the future. Recipients were asked to list species that are spreading and cause problems in agroecosystems, and to rate these according to three scores (degree of weediness, degree of spread potential, and degree of control success), with three levels for each score (low, medium and high). In total, 281 species were reported from 26 European countries. Most of them were annuals (48%), followed by perennials (34%) and biennials (14%). There were significant differences in weed scores among these life forms. Weed scores were unrelated to each other, implying that they have different meanings with respect to the biology of the species. Weed scores did not correlate with European range size, implying that they indicate the weediness of the species independently of the geographical distribution and can be used to prioritize weed species for management.

**noxious weed lists / risk assessment / surveys / weediness / weed control**

## 1. INTRODUCTION

The increasing number of non-native plant species in most regions is a major component of global change [26] and includes both the spread of exotic species into natural environments and the spread of weeds in agroecosystems. Weed communities of arable land may change rapidly over time and vary among different regions. Within the last few decades, a general decline in weed species has been observed in parts of Europe, mostly as a result of increased fertilization and effective control [1, 4]. This decline has mostly affected species of arable land that are a valuable component of biodiversity, some native weeds being endangered species and thus having a high conservation value [15, 25]. However, it has also been observed that certain species are increasing in abundance, including species that are difficult to control and causing extensive weed problems [1]. For any country, new plant species may originate by naturalization of intentionally introduced species, by the onset of the spread of already present species, by natural immigration of species that expand their range, or by unintentional introduction of species from abroad. The latter include species from other continents and from other countries on the same continent.

Changes in the composition of weed floras are associated with many factors and their interactions, including ecological traits of the species involved and the recipient habitats, and patterns of land-use change. Among the factors that may promote the establishment of new weed species are the evolution of her-

bicide resistance [23], increasing extensivisation and extension of late spring-seeded field crops [2], reduction of early-emerging weeds due to herbicide control, favoring late-emerging and competitively strong weeds [22], and climatic change, leading to the range expansion of weeds from warmer climates [18]. In Germany, the observed changes in the weed flora during the last few decades were attributed to changes in arable farming practice, including fertilizing, the use of more competitive crops, enhanced weed control, modifications in sowing technique, and purification of seed [1].

Climate change, land-use change, and the increasing international trade is likely increasing the number of new weed species in European countries. An important objective of noxious weed management is to reduce the spread of serious weeds and to prevent their introduction from adjacent geographic areas. Weeds are dispersed by various agents, but human activity is probably the most important one [17]. Therefore, it is essential to assess which weed species are problematic and to set priorities with regard to developing weed management strategies. In order to prevent new weed problems, the following steps are necessary [28, 30]: (1) identification of foreign weeds that could cause problems by performing weed risk assessments, (2) early detection of infestations if the species is already established, (3) assessment of the invader's noxious potential, and (4) implementation of the necessary measures to control or eradicate new weed species. Performing a weed risk assessment is common practice, for example, in New Zealand or Australia [3, 8, 16].

\* Corresponding author: ewald.weber@env.ethz.ch

In this paper, we present the results of a Europe-wide survey of troublesome weed species in various agroecosystems. Our aim was to evaluate currently problematic weed species or those that could potentially cause new weed problems within arable lands of Europe, and to assess their weediness. The questions addressed were: (1) what are the most important current weed species in European agroecosystems? (2) how are these species rated by weed scientists? (3) how is the rating of the weeds related to their distribution?

## 2. MATERIALS AND METHODS

### 2.1. Weed survey

We conducted a Europe-wide survey by sending form sheets to leading weed scientists. Recipients were asked to provide species lists of weeds (1) that either generally show a tendency of increasing spread, or (2) have showed a rapid increase in infested areas within the last 20 years, (3) that are causing problems in agricultural habitats, or (4) species that have been present for a long time but recently have begun to spread, or (5) recently introduced and spreading species. In addition, recipients were asked to indicate the occurrence (presence/absence) of each of the species in the following agroecosystems: (1) fodder plants and pastures, (2) cereals, (3) grain legumes, (4) root crops, (5) vegetables and ornamentals, (6) orchards, (7) vineyards, and (8) other agricultural areas. The above definitions for the agroecosystems may differ from crop systems defined by weed scientists, but for the present large-scale survey, the form sheet was kept as simple as possible.

Each species could be rated by the recipients at three levels (low, medium and high) for three scores, representing different aspects of the biology of the weed and its control: (1) potential for further spread, (2) weediness (local abundance), and (3) success of control. For the sake of simplicity, no a priori distinctions for each agroecosystem were made. For the purpose of this study, the information that could be obtained is sufficient.

A database was created comprising all listed weed species with their respective occurrences in the agroecosystems and countries. We screened species for synonyms and tabulated them according to subsequent analyses. For a general description, the life forms and families were identified for each species. The range size in Europe was added to each species, and range size was expressed as the number of European countries where the species occurs. These data were taken from the *Flora Europaea* database (URL: <http://rbg-web2.rbge.org.uk/FE/fe.html>).

### 2.2. Rating of species

For each species, the scores provided by the weed scientists were averaged in order to obtain a general rating for “spread potential”, “weediness”, and “control success”, respectively. We then ranked the species according to the first two weed scores and listed the species with the highest rankings for each of the crop systems. The ranking was done as follows: first, species were ranked according to “spread potential”. Within the highest values of this score, species were ranked according to “weediness”. The fifteen species with the highest ranking were

defined as the most troublesome weeds. The score for “control success” was not considered at this point since it reflects a different aspect of weediness, e.g. how easy a species is to control, but also the availability of control methods and the efforts put into weed control. The score for “control success” was used for subsequent analyses.

### 2.3. Relationships between distribution and weed scores

We used regression analyses in order to investigate the relationships among the three weed scores and between weed scores and geographic distribution. This shows, for example, whether species rated as serious weeds were also among the most widespread ones. Analysis of variance was used to test for differences in weed scores and geographic distribution among life forms.

## 3. RESULTS

### 3.1. Number of weed species

In total, 281 weed species were reported, comprising 176 genera and 48 families (Appendix 1). The absolute number of species for individual countries varied considerably, ranging from 5 to 100. The mean number of species per crop system ranged from 1.4 to 12.5 (Tab. I), and high values were apparent in countries in Eastern Europe, e.g., Romania, Poland and Bulgaria (Tab. I).

The largest families were the Asteraceae (61 species), Poaceae (55), Brassicaceae (15), Polygonaceae (14) and Apiaceae (11). The most significant genera were *Amaranthus*, *Bromus* and *Rumex* with seven species each. The species:family ratio was 6.2, the species:genera ratio 1.6.

Although many of the weeds were annuals, the species reported formed an ecologically diverse group comprising all life forms (Tab. II). Herbaceous perennials made up 32.5% of all species. The distribution of life forms among crop systems varied: annuals were predominant in cereals, perennials in cereals and orchards (Tab. III), although differences among crop systems were not pronounced. The number of weed species reported for different crop systems was rather high, with most weeds occurring in cereals, and vegetables and ornamentals (Tab. III).

### 3.2. Variation of weed scores

Most species obtained intermediate scores (Fig. 1), and the relative fraction of annuals and perennials, respectively, differed among classes of scores. There were more perennials with high scores for weediness than annuals. Perennials generally obtained low scores for control success (Fig. 1). The three life forms, annuals, biennials and perennials, differed significantly with respect to the mean score for spread potential and the mean score for control success (Tab. IV). There were no differences in the number of countries for which the species was listed, and for European range size (Tab. IV).

Pronounced differences in scores were apparent among crop systems, as well as among life forms (Fig. 2). Generally, weeds

**Table I.** Number of weed species with a high spread potential reported for 26 European countries in a questionnaire.

| Country                 | Species per country | Mean No. of species per crop system |
|-------------------------|---------------------|-------------------------------------|
| Albania                 | 42                  | 6.0                                 |
| Austria                 | 21                  | 5.3                                 |
| British Isles           | 28                  | 3.5                                 |
| Bulgaria                | 44                  | 6.3                                 |
| Czech Republic          | 5                   | 2.5                                 |
| Cyprus                  | 21                  | 2.6                                 |
| Denmark                 | 7                   | 1.4                                 |
| Finland                 | 17                  | 2.8                                 |
| France                  | 20                  | 4.0                                 |
| Germany                 | 42                  | 5.3                                 |
| Greece                  | 7                   | 1.4                                 |
| Hungary                 | 39                  | 4.9                                 |
| Ireland                 | 6                   | 2.0                                 |
| Italy                   | 41                  | 5.1                                 |
| Lithuania               | 23                  | 3.8                                 |
| Netherlands             | 21                  | 3.0                                 |
| Norway                  | 15                  | 2.1                                 |
| Poland                  | 53                  | 8.8                                 |
| Portugal                | 43                  | 5.4                                 |
| Romania                 | 100                 | 12.5                                |
| Slovakia                | 29                  | 3.6                                 |
| Spain                   | 45                  | 5.6                                 |
| Sweden                  | 17                  | 2.4                                 |
| Turkey                  | 27                  | 3.9                                 |
| Yugoslavia <sup>1</sup> | 53                  | 6.6                                 |
| Ukraine                 | 23                  | 3.8                                 |

<sup>1</sup> Slovenia and Croatia.

of orchards and vineyards obtained higher scores than weeds of the other crop systems. The difficulty of controlling perennial weeds is clearly seen by their low scores for control success, whereas annuals and biennials obtained higher scores (Fig. 2).

### 3.3. Weed rankings for individual culture systems

The fifteen weed species with the highest rankings for spread potential and weediness were often the same, but differences

**Table II.** Life form distribution of weed species with a high spread potential as obtained by a Europe-wide survey.

| Life form         | N   | %    |
|-------------------|-----|------|
| Annuals           | 135 | 48.4 |
| Hemicryptophytes  | 65  | 23.3 |
| Biennials         | 39  | 14.0 |
| Geophytes         | 30  | 10.8 |
| Aquatic plants    | 3   | 1.1  |
| Nanophanerophytes | 4   | 1.4  |
| Chamaephytes      | 2   | 0.7  |
| Vines             | 1   | 0.4  |

among culture systems were apparent. The species are listed in Table V. The lists contain numerous alien plants.

### 3.4. Relationships of weed scores to each other

The three weed scores exhibited only weak relationships to each other (Fig. 3). Mean score for spread potential significantly correlated with mean score for weediness (regression analysis:  $r^2 = 0.23$ ,  $P < 0.001$ ), and mean score for spread potential significantly correlated with mean score for control success (regression analysis:  $r^2 = 0.01$ ,  $P = 0.034$ ). The variation, however, was large, as was the overlap of life forms (Fig. 3).

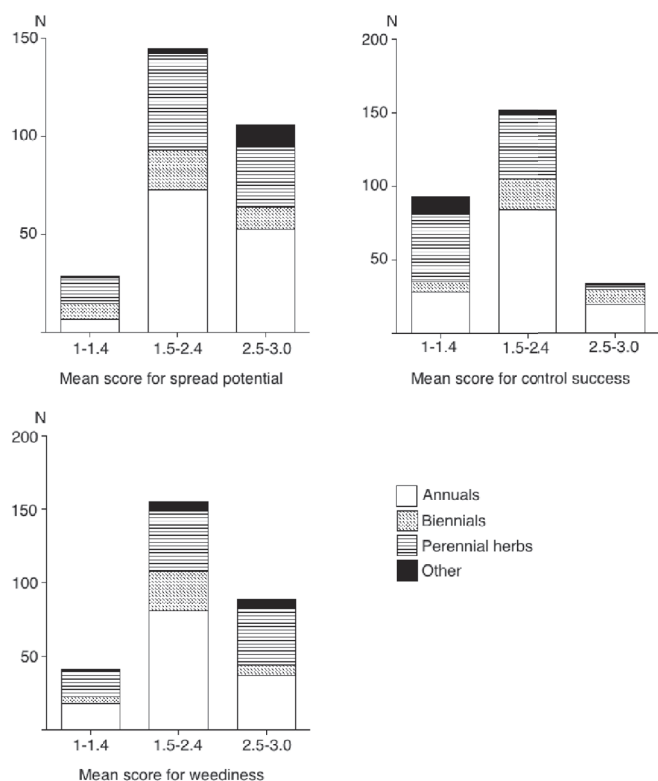
### 3.5. Relationships of weed scores to range size and crop systems

Range size in Europe significantly correlated with mean score for spread potential (regression analysis:  $r^2 = 0.03$ ,  $P = 0.002$ ) but the relationship was weak (Fig. 4). There was no relationship between European range size and mean score for weediness or mean score for control success (Fig. 4).

The number of countries for which a weed was listed significantly correlated with European range size (regression analysis:  $r^2 = 0.10$ ,  $P < 0.001$ ), but again, the relationship was weak. There was also only a weak relationship between number of crop systems per species and range size (regression analysis:  $r^2 = 0.13$ ,  $P < 0.001$ ). Ranking the weeds according to their range size in Europe and relating them to the number of countries from which the species was reported as a weed reveals a sharp discrepancy between range size and number of countries (Fig. 5). Most of the weeds have a range that is larger than the range where they are perceived as weeds.

**Table III.** Number of weed species with a high spread potential in different crop systems as obtained by a Europe-wide survey.

| Crop system                | N   | Life form |          |           |
|----------------------------|-----|-----------|----------|-----------|
|                            |     | Annual    | Biennial | Perennial |
| Fodder plants and pastures | 140 | 61        | 20       | 52        |
| Cereals                    | 186 | 103       | 21       | 55        |
| Grain legumes              | 128 | 81        | 14       | 30        |
| Root crops                 | 140 | 81        | 22       | 34        |
| Vegetables and ornamentals | 157 | 84        | 23       | 45        |
| Orchards                   | 152 | 73        | 20       | 53        |
| Vineyards                  | 119 | 67        | 14       | 34        |
| Other agricultural areas   | 36  | 14        | 4        | 15        |



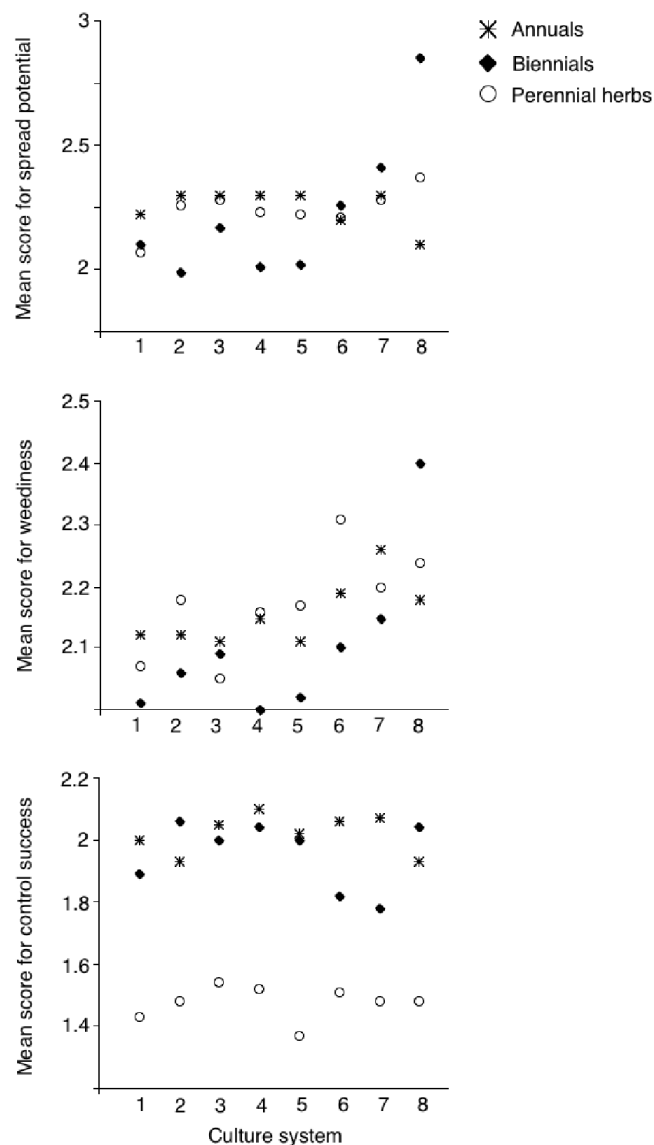
**Figure 1.** Histograms showing the number of weed species in classes of three different weed scores, according to perennation of the species. Data were obtained by a Europe-wide survey.

#### 4. DISCUSSION

Surveys and assessing noxious weed lists are useful tools for policy-making and weed legislation, and have been compiled for various regions and purposes [5, 6, 11, 17, 21, 24]. The present weed survey cannot be assumed to be extensive and complete, especially since the number of species listed per country varies greatly. Therefore no attempts were made to conduct detailed analyses of patterns of geographic distribution of individual species within Europe and among countries. However, for the purpose of general analyses with regard to variation in weed scores and number of weeds in different crop systems, the species obtained represent a sufficient sample size.

One aim of this survey was to obtain basic information on current weed problems in European countries and to evaluate species that could increase in their significance as weeds in the future. Assessments of problem species are often made by asking experts [5, 6] and such a direct approach may give meaningful results for the management of weeds. Whereas extensive field studies would be necessary to quantify the abundance and diversity of weeds, a survey is a fast and inexpensive approach allowing one to cover a large area.

The species list obtained (see Appendix 1) is rather extensive and demonstrates that weeds are still a significant problem in European agriculture. Several authors have pointed out that weed floras have changed rapidly within the last few decades



**Figure 2.** Mean values for three different weed scores of weed species occurring in different crop systems. Data were obtained by a Europe-wide survey. Crop systems: (1) fodder plants and pastures, (2) cereals, (3) grain legumes, (4) root crops, (5) vegetables and ornamentals, (6) orchards, (7) vineyards, and (8) other agricultural areas.

**Table IV.** Test for differences in weed scores and geographic distribution among three life forms of European weeds. Table entries are analysis of variance results. Minimum, mean and maximum scores refer to values within species.

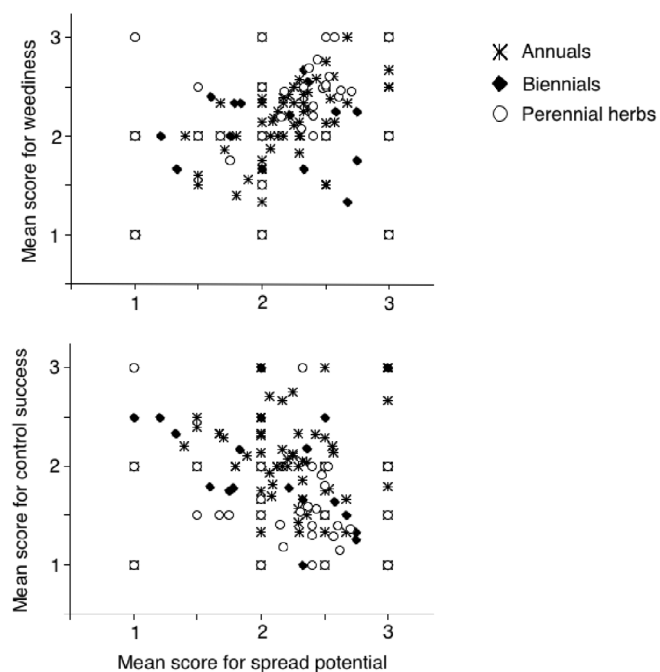
| Character                              | F-value | P-value   |
|--|---------|-----------|
| Score for spread potential             | 3.9     | 0.020*    |
| Score for weediness                    | 0.51    | 0.601     |
| Score for control success              | 19.5    | <0.001*** |
| Number of crop systems                 | 6.0     | 0.003**   |
| Number of countries listed             | 2.8     | 0.064     |
| European range size (No. of countries) | 2.2     | 0.116     |

**Table V.** Troublesome weed species in different culture systems as revealed by a Europe-wide survey. For each culture system, the fifteen most significant weed species are listed. For explanations, see text. \* indicates that the species is alien to Europe.

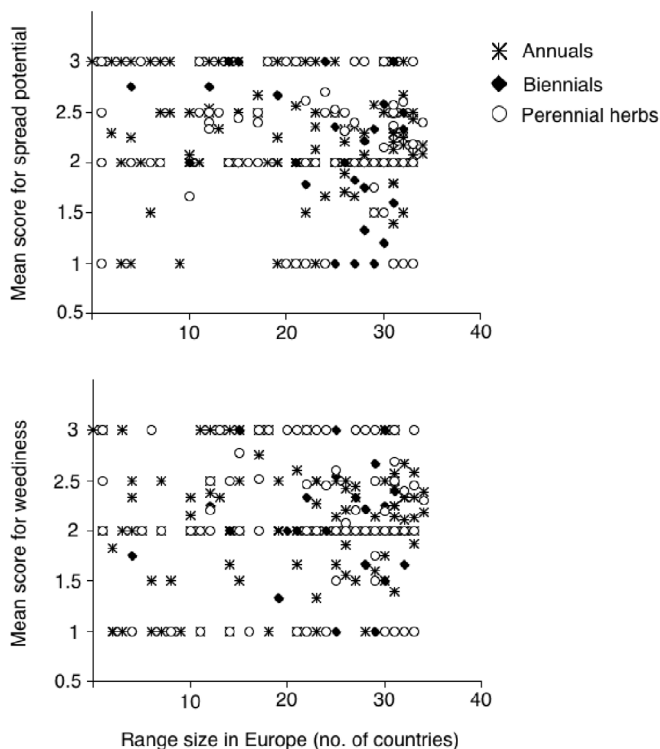
|                                   |                                    |                                |
|-----------------------------------|------------------------------------|--------------------------------|
| <b>Fodder plants and pastures</b> |                                    |                                |
| <i>Amaranthus powellii</i> *      | <i>Hordeum murinum</i>             | <i>Poa trivialis</i>           |
| <i>Amsinckia micrantha</i> *      | <i>Lathyrus tuberosus</i>          | <i>Ranunculus acris</i>        |
| <i>Cuscuta epithymum</i>          | <i>Malva silvestris</i>            | <i>Silene aegyptica</i>        |
| <i>Duchesnea indica</i> *         | <i>Phlomis fruticosa</i>           | <i>Veronica persica</i> *      |
| <i>Erigeron annuus</i> *          | <i>Poa palustris</i>               | <i>Xanthium italicum</i> *     |
| <b>Cereals</b>                    |                                    |                                |
| <i>Acroptilon repens</i>          | <i>Holcus mollis</i>               | <i>Poa palustris</i>           |
| <i>Alisma plantago-aquatica</i>   | <i>Lathyrus tuberosus</i>          | <i>Poa trivialis</i>           |
| <i>Amaranthus paniculatus</i> *   | <i>Lotus tenuis</i>                | <i>Scirpus mucronatus</i>      |
| <i>Conyza bonariensis</i> *       | <i>Malva silvestris</i>            | <i>Silene aegyptica</i>        |
| <i>Diplachne fascicularis</i>     | <i>Oryza sativa</i> *              | <i>Vicia villosa</i>           |
| <b>Grain legumes</b>              |                                    |                                |
| <i>Amaranthus powellii</i> *      | <i>Conyza bonariensis</i> *        | <i>Sicyos angulatus</i> *      |
| <i>Amsinckia micrantha</i> *      | <i>Erigeron annuus</i> *           | <i>Silene aegyptica</i>        |
| <i>Asclepias syriaca</i> *        | <i>Lactuca saligna</i>             | <i>Sorghum nigrum</i> *        |
| <i>Chenopodium ficifolium</i>     | <i>Matricaria matricarioides</i> * | <i>Veronica persica</i> *      |
| <i>Conyza albida</i> *            | <i>Salsola kali</i>                | <i>Xanthium italicum</i> *     |
| <b>Root crops</b>                 |                                    |                                |
| <i>Amaranthus paniculatus</i> *   | <i>Erigeron annuus</i> *           | <i>Silene aegyptica</i>        |
| <i>Amaranthus powellii</i> *      | <i>Lactuca saligna</i>             | <i>Sorghum bicolor</i> *       |
| <i>Chenopodium ficifolium</i>     | <i>Lotus tenuis</i>                | <i>Sorghum nigrum</i> *        |
| <i>Conyza albida</i> *            | <i>Matricaria matricarioides</i> * | <i>Veronica persica</i> *      |
| <i>Conyza bonariensis</i> *       | <i>Rubus caesius</i>               | <i>Xanthium italicum</i> *     |
| <b>Vegetables and ornamentals</b> |                                    |                                |
| <i>Acroptilon repens</i>          | <i>Hordeum murinum</i>             | <i>Orobanche ramosa</i>        |
| <i>Amaranthus paniculatus</i> *   | <i>Lactuca saligna</i>             | <i>Silene aegyptica</i>        |
| <i>Amaranthus powellii</i> *      | <i>Lotus tenuis</i>                | <i>Solanum physalifolium</i> * |
| <i>Chenopodium ficifolium</i>     | <i>Malva silvestris</i>            | <i>Veronica persica</i> *      |
| <i>Erigeron annuus</i> *          | <i>Orobanche aegyptica</i>         | <i>Xanthium italicum</i> *     |
| <b>Orchards</b>                   |                                    |                                |
| <i>Acroptilon repens</i>          | <i>Heracleum mantegazzianum</i> *  | <i>Lotus tenuis</i>            |
| <i>Amaranthus paniculatus</i> *   | <i>Holcus mollis</i>               | <i>Malva silvestris</i>        |
| <i>Conyza albida</i> *            | <i>Hordeum murinum</i>             | <i>Ranunculus acris</i>        |
| <i>Conyza bonariensis</i> *       | <i>Lathyrus tuberosus</i>          | <i>Silene aegyptica</i>        |
| <i>Euphorbia nutans</i> *         | <i>Lavatera cretica</i>            | <i>Vicia villosa</i>           |
| <b>Vineyards</b>                  |                                    |                                |
| <i>Acroptilon repens</i>          | <i>Crepis aspera</i> *             | <i>Malva silvestris</i>        |
| <i>Amaranthus chlorostachys</i> * | <i>Holcus mollis</i>               | <i>Salsola kali</i>            |
| <i>Amaranthus paniculatus</i> *   | <i>Hordeum murinum</i>             | <i>Silene aegyptica</i>        |
| <i>Conyza bonariensis</i> *       | <i>Lathyrus tuberosus</i>          | <i>Veronica persica</i> *      |
| <i>Conyza sumatrensis</i> *       | <i>Lotus tenuis</i>                | <i>Vicia villosa</i>           |

due to land use and environmental changes [1, 4, 7, 9, 22]. Besides a decline in species number, these changes also included the appearance of new weeds. Large-scale surveys of weed floras are necessary to recognize potential new weeds for a region and to allow predictions of their impact. Plant species may become serious weeds due to a change in cultural practices, although the same changes can lead to a decrease of other species [14, 19]. New weeds may arise through immigration of expanding species or the beginning of spread of already present species.

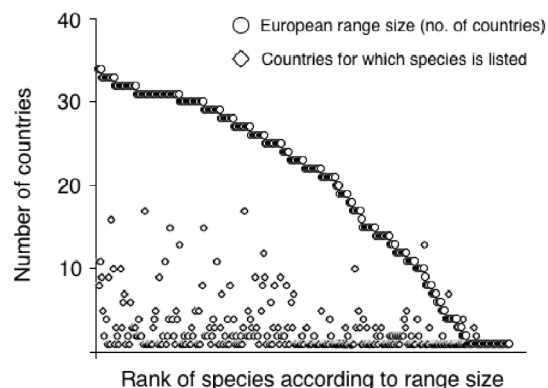
The most significant weed species identified in this study in terms of their distribution are mostly the same as found by [23] and [10], with the exception of *Abutilon theophrasti*, *Sinapis arvensis*, *Sorghum halepense*, and some other species with a small geographic distribution. Despite a substantial variation in the number of species reported for each country, a high concentration of weed species was apparent in countries bordering the Mediterranean sea and in Eastern Europe. Weed management in Eastern Europe is generally less extensive than in Western Europe, leading to species-rich weed floras. The decline in



**Figure 3.** Relationships among three different weed scores applied to weed species of Europe. Data were obtained in a Europe-wide survey.



**Figure 4.** Relationships between weed scores and the range size in Europe. Range size is expressed as the number of countries in which the species occurs.



**Figure 5.** Rank of range size of weed species in Europe, with the number of countries in which the plant is perceived as a weed. Range size is expressed as the number of countries in which the species occurs.

species richness of arable land in these regions has not yet reached the levels of Western Europe. This is, for example, illustrated by *Agrostemma githago*, which was reported as a serious weed in Romania, but is almost extinct in Western Europe.

Whether a species is perceived as a weed or not varies from the point of view of the assessors [19, 29] but also depends on the geographic location, if the plant is a weed in one country but not in another. In this study, the weed scores given by experts were not or only weakly related to range size and number of crop systems infested, suggesting that these scores reflect at least partly some aspects of the weed's ecology and not just whether the species is widespread or not. The scores are most likely associated with the life-history of the species. The three different weed scores were only weakly related to each other, again implying that they have different meanings and are associated with different aspects of the species' biology. Scores for spread potential may be related to dispersal mechanisms, and scores for weediness to the competitive ability of the weed with the crop. The scores for control success may indicate the availability of tools to control the species, as well as the ability of the species to tolerate control measures.

Several authors have related the taxonomic position of a species (family, genus) to its likelihood to become invasive. Although such an approach may be difficult, it was found that some families are highly overrepresented by weed species or invasive plants compared with the global family size [13, 20, 27]. Mack [12] has emphasized that a species of a genus or family with weedy congeners is more likely to become a weed. Indeed, in this study, most species belong to the genera *Amaranthus*, *Bromus* and *Rumex*, which contribute many weed species worldwide. Considering the whole set of weeds reported, diversity was high, e.g., they were distributed among many families and genera. These results make generalizations with regard to weediness and taxonomic position difficult.

The discrepancy between range size in Europe and the number of countries for which the species was listed as a weed has important implications. First, it means that species that are weeds currently in a few countries only, could expand in the

future and become weeds in further countries. Second, it implies that there is a large potential of increasing weed problems in European agriculture. However, there could also be a bias due to different points of view of the assessors. Further studies should aim at predicting the impact of the species obtained in this survey in various regions where they are not yet present. These species need to be monitored and their appearance in new countries must be observed with caution.

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**Appendix 1.** Weed species listed in a Europe-wide survey.

| Species                           | Family          | LF | SPR  | WED  | CON  | Crop systems           | Regions    |
|-----------------------------------|-----------------|----|------|------|------|------------------------|------------|
| <i>Abutilon theophrastii</i> *    | Malvaceae       | t  | 2.08 | 2.15 | 1.7  | 1, 2, 3, 4, 5, 6       | C, E, S    |
| <i>Achillea millefolium</i>       | Asteraceae      | h  | 1.75 | 1.75 | 1.5  | 1, 3, 5, 6, 7, 8       | E          |
| <i>Acroptilon repens</i>          | Asteraceae      | h  | 2.5  | 2.5  | 1    | 2, 5, 6, 7             | S          |
| <i>Aethusa cynapium</i>           | Apiaceae        | u  | 1.78 | 2.33 | 1.78 | 4, 5                   | C, E, N, S |
| <i>Agropyron repens</i>           | Poaceae         | g  | 2.48 | 2.48 | 1.91 | 1, 2, 3, 4, 5, 6, 7    | C, E, N, S |
| <i>Agrostemma githago</i>         | Caryophyllaceae | t  | 2    | 2    | 2    | 2                      | E          |
| <i>Alisma plantago-aquatica</i>   | Alismataceae    | a  | 3    | 3    | 1    | 2                      | S          |
| <i>Allium oleraceum</i>           | Liliaceae       | g  | 2    | 1    | 1    | 1, 5, 6, 7, 8          | E          |
| <i>Allium rotundum</i>            | Liliaceae       | g  | 1    | 1    | 1    | 1                      | E          |
| <i>Alopecurus geniculatus</i>     | Poaceae         | h  | 2.5  | 2    | 1    | 1, 2, 4, 5             | N          |
| <i>Alopecurus myosuroides</i>     | Poaceae         | t  | 2.21 | 2.21 | 2.08 | 1, 2, 3, 4, 5, 6       | C, E, N, S |
| <i>Amaranthus albus</i> *         | Amaranthaceae   | t  | 1.67 | 2    | 2.33 | 1, 2, 3, 4, 6, 7       | E, S       |
| <i>Amaranthus blitoides</i> *     | Amaranthaceae   | t  | 2    | 2    | 3    | 2, 3, 4, 5             | E, S       |
| <i>Amaranthus chlorostachys</i> * | Amaranthaceae   | t  | 2    | 2.5  | 2.5  | 1, 3, 4, 5, 6, 7       | E          |
| <i>Amaranthus hybridus</i> *      | Amaranthaceae   | t  | 2.5  | 2.5  | 2    | 2, 3, 4, 5, 6, 7       | S          |
| <i>Amaranthus paniculatus</i> *   | Amaranthaceae   | t  | 3    | 3    | 2    | 2, 4, 5, 6, 7          | E          |
| <i>Amaranthus powellii</i> *      | Amaranthaceae   | t  | 3    | 2.5  | 2    | 1, 2, 3, 4, 5, 6, 7    | E          |
| <i>Amaranthus retroflexus</i> *   | Amaranthaceae   | t  | 2.33 | 2.42 | 2.05 | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, N, S |
| <i>Ambrosia artemisiifolia</i> *  | Asteraceae      | t  | 2.54 | 2.38 | 1.77 | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, S    |
| <i>Ammi majus</i>                 | Apiaceae        | t  | 2.33 | 2.33 | 1.67 | 2, 4, 5                | S          |
| <i>Amsinckia micrantha</i> *      | Boraginaceae    | t  | 3    | 2    | 3    | 1, 2, 3                | N          |
| <i>Amsinckia sp.</i> *            | Boraginaceae    | t  | 3    | 3    | 2    | 2                      | N          |
| <i>Anagallis arvensis</i>         | Primulaceae     | t  | 1.8  | 1.4  | 2    | 1, 2, 3, 4, 5, 6, 7    | E, N, S    |
| <i>Anchusa arvensis</i>           | Boraginaceae    | u  | 1    | 1.5  | 1.5  | 3, 4, 5                | C, E       |
| <i>Anthemis arvensis</i>          | Asteraceae      | t  | 1.8  | 2    | 2    | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Anthemis austriaca</i>         | Asteraceae      | u  | 2    | 2    | 2    | 1, 2, 3, 6, 7          | E          |
| <i>Apera spica-venti</i>          | Poaceae         | h  | 2.53 | 2.6  | 2    | 1, 2, 3, 4             | E, N, S    |
| <i>Araujia sericifera</i> *       | Asclepiadaceae  | p  | 1    | 2    | 1    | 6                      | S          |
| <i>Arctium lappa</i>              | Asteraceae      | h  | 2    | 3    | 1    | 2, 5, 6, 7, 8          | E          |
| <i>Arrhenatherum elatius</i>      | Poaceae         | h  | 2    | 2    | 2    | 2                      | N          |
| <i>Artemisia absinthium</i>       | Asteraceae      | c  | 2    | 2    | 1    | 1, 2, 5, 6, 7          | E          |
| <i>Artemisia vulgaris</i>         | Asteraceae      | h  | 2.4  | 2.2  | 1.4  | 2, 3, 4, 5, 6, 7       | E, N, S    |
| <i>Asclepias syriaca</i> *        | Asclepiadaceae  | g  | 3    | 1    | 1    | 2, 3, 4                | E          |
| <i>Aster squamatus</i> *          | Asteraceae      | u  | 2.75 | 2.25 | 1.25 | 1, 6, 7                | C, S       |
| <i>Atriplex patula</i>            | Chenopodiaceae  | t  | 2.5  | 2    | 1.5  | 1, 2, 3, 5, 6, 7       | E, N       |
| <i>Avena barbata</i>              | Poaceae         | t  | 2    | 2    | 2    | 2, 6, 7                | S          |
| <i>Avena fatua</i>                | Poaceae         | t  | 2.57 | 2.14 | 2.14 | 1, 2, 3, 4, 5, 6       | C, E, N, S |
| <i>Avena sterilis</i>             | Poaceae         | t  | 2.25 | 2.5  | 2.75 | 2, 3, 6, 7             | S          |
| <i>Barbarea vulgaris</i>          | Brassicaceae    | u  | 2.33 | 2.67 | 1    | 1, 4                   | C, E, N    |
| <i>Bidens tripartita</i>          | Asteraceae      | t  | 2.29 | 2    | 1.57 | 2, 3, 4, 5             | C, S       |
| <i>Bidens vulgata</i> *           | Asteraceae      | t  | -    | 1    | 3    | 3, 4                   | E          |
| <i>Bifora radians</i>             | Asteraceae      | t  | 2.5  | 2    | 1.75 | 2                      | E, S       |
| <i>Bothriochloa ischaemum</i>     | Poaceae         | h  | -    | 3    | 1    | 1                      | E          |
| <i>Brassica napus</i>             | Brassicaceae    | u  | 3    | 2    | 2    | 4                      | E          |
| <i>Bromus catharticus</i> *       | Poaceae         | u  | 2    | 1    | -    | 1, 5, 6                | S          |
| <i>Bromus commutatus</i>          | Poaceae         | t  | 2    | 2    | 1    | 2                      | N          |
| <i>Bromus diandrus</i>            | Poaceae         | t  | 2    | 2    | 1.5  | 2, 6, 7                | N, S       |
| <i>Bromus mollis</i>              | Poaceae         | t  | 2.5  | 2.5  | 1.5  | 2, 3                   | N          |
| <i>Bromus rigidus</i>             | Poaceae         | t  | 2    | 3    | 1    | 2                      | S          |

## Appendix 1. Continued.

| Species                         | Family         | LF | SPR  | WED  | CON  | Crop systems           | Regions    |
|---------------------------------|----------------|----|------|------|------|------------------------|------------|
| <i>Bromus secalinus</i>         | Poaceae        | t  | 2    | 2    | 1    | 2, 3, 4, 7             | C, N, S    |
| <i>Bromus sterilis</i>          | Poaceae        | t  | 2.29 | 2.14 | 1.43 | 1, 2, 7                | C, E, N    |
| <i>Calamagrostis epigejos</i>   | Poaceae        | h  | 3    | 3    | 1.5  | 1, 6, 7, 8             | E          |
| <i>Calystegia sepium</i>        | Convolvulaceae | g  | 2.4  | 2.2  | 1.8  | 2, 4, 5, 6, 7          | C, E, S    |
| <i>Cannabis sativa</i>          | Cannabaceae    | t  | 1    | 2    | 1    | 3, 4                   | E          |
| <i>Capsella bursa-pastoris</i>  | Brassicaceae   | t  | 2.07 | 1.87 | 2.71 | 1, 2, 3, 4, 5, 6, 7    | C, E, S    |
| <i>Cardamine hirsuta</i>        | Brassicaceae   | t  | 2.67 | 2.33 | 1.33 | 2, 5, 6                | C, S       |
| <i>Cardaria draba</i>           | Brassicaceae   | h  | 2    | 2    | 2    | 2, 3, 6, 7             | E          |
| <i>Carduus acanthoides</i>      | Asteraceae     | h  | 1    | 1    | 2    | 1                      | E          |
| <i>Carduus nutans</i>           | Asteraceae     | u  | 2    | 2    | 1    | 1, 5, 6, 7             | E          |
| <i>Centaurea cyanus</i>         | Asteraceae     | u  | 1.83 | 2.33 | 2.17 | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Centaurea diluta</i>         | Asteraceae     | h  | 2    | 3    | 2    | 2, 3, 4                | S          |
| <i>Centaurea scabiosa</i>       | Asteraceae     | h  | 2    | 2    | 1    | 1, 2, 5, 6             | E          |
| <i>Chamaemelum fuscatum</i>     | Asteraceae     | t  | 2    | 2    | 2    | 2, 6, 7                | S          |
| <i>Chamaemelum mixtum</i>       | Asteraceae     | t  | 2    | 2    | 2    | 2, 6, 7                | S          |
| <i>Chenopodium album</i>        | Chenopodiaceae | t  | 2.43 | 2.58 | 2.32 | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, N, S |
| <i>Chenopodium ficifolium</i>   | Chenopodiaceae | t  | 3    | 2    | 3    | 2, 3, 4, 5             | S          |
| <i>Chenopodium hybridum</i>     | Chenopodiaceae | t  | 1.5  | 2    | 2.5  | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Chenopodium polyspermum</i>  | Chenopodiaceae | t  | 2    | 1.5  | 2.5  | 2, 3, 4, 5, 6, 7       | E, S       |
| <i>Chenopodium rubrum</i>       | Chenopodiaceae | t  | -    | 2    | 3    | 3, 4, 5                | E          |
| <i>Cichorium intybus</i>        | Asteraceae     | h  | 2    | 2    | 1    | 3                      | S          |
| <i>Cirsium arvense</i>          | Asteraceae     | g  | 2.37 | 2.69 | 1.59 | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, N, S |
| <i>Cirsium setosum</i>          | Asteraceae     | g  | 1    | 1    | 1    | 1, 2, 3, 4, 5, 6, 8    | E          |
| <i>Conium maculatum</i>         | Apiaceae       | u  | 1.6  | 2.4  | 1.8  | 1, 2, 4, 5             | C, E       |
| <i>Consolida orientalis</i>     | Ranunculaceae  | t  | 3    | 2    | 1    | 2                      | S          |
| <i>Consolida regalis</i>        | Ranunculaceae  | t  | 1    | 1    | 1    | 1, 2, 8                | E          |
| <i>Convolvulus arvensis</i>     | Convolvulaceae | g  | 2.15 | 2.19 | 1.41 | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, S    |
| <i>Conyza albida</i> *          | Asteraceae     | t  | 3    | 3    | 2    | 2, 3, 4, 6, 7          | S          |
| <i>Conyza bonariensis</i> *     | Asteraceae     | t  | 3    | 3    | 1.5  | 2, 3, 4, 6, 7          | S          |
| <i>Conyza canadensis</i> *      | Asteraceae     | u  | 2.58 | 2.25 | 1.64 | 1, 2, 3, 4, 5, 6, 7    | C, E, S    |
| <i>Conyza sumatrensis</i> *     | Asteraceae     | t  | 3    | 3    | 2    | 7                      | C          |
| <i>Corchorus olitorius</i> *    | Tiliaceae      | t  | 3    | 1    | 1    | 3, 5                   | S          |
| <i>Coronilla varia</i>          | Fabaceae       | h  | 2    | 1    | 1    | 1, 3, 5, 6, 7          | E          |
| <i>Crepis aspera</i> *          | Asteraceae     | t  | 3    | 3    | 3    | 7                      | S          |
| <i>Crepis bursifolia</i>        | Asteraceae     | g  | 2    | 1    | -    | 5                      | S          |
| <i>Cuscuta campestris</i> *     | Cuscutaceae    | t  | 2.5  | 2.75 | 1.33 | 1, 3, 4, 5             | E, S       |
| <i>Cuscuta epithymum</i>        | Cuscutaceae    | t  | 3    | 3    | 1    | 1                      | S          |
| <i>Cynanchum acutum</i>         | Asclepiadaceae | n  | -    | 2    | 1    | 1                      | S          |
| <i>Cynodon dactylon</i>         | Poaceae        | g  | 2.7  | 2.45 | 1.36 | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Cyperus difformis</i>        | Cyperaceae     | t  | 3    | 1    | 2    | 2, 4, 5                | E          |
| <i>Cyperus eragrostis</i> *     | Cyperaceae     | h  | 2    | 1    | -    | 5                      | S          |
| <i>Cyperus esculentus</i>       | Cyperaceae     | g  | 2.4  | 2.2  | 1    | 1, 2, 3, 4, 5, 6       | C, S       |
| <i>Cyperus rotundus</i>         | Cyperaceae     | g  | 2.4  | 2    | 2    | 1, 4, 5, 6, 7          | S          |
| <i>Dactylis glomerata</i>       | Poaceae        | h  | 1    | 1    | 2    | 1, 6, 7                | S          |
| <i>Datura innoxia</i> *         | Solanaceae     | t  | 3    | 1    | -    | 5                      | S          |
| <i>Datura stramonium</i> *      | Solanaceae     | t  | 2.07 | 2    | 1.93 | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Daucus carota</i>            | Apiaceae       | u  | 2.33 | 1.67 | 1.67 | 1, 2, 3, 4, 5, 6, 7    | C, E, N    |
| <i>Descurainia sophia</i>       | Brassicaceae   | u  | 1.2  | 2    | 2.5  | 1, 2, 3, 4, 5, 6       | C, E       |
| <i>Dichanthium saccharoides</i> | Poaceae        | h  | 3    | 2    | 1    | 7                      | C          |

## Appendix 1. Continued.

| Species                           | Family          | LF | SPR  | WED  | CON  | Crop systems           | Regions    |
|-----------------------------------|-----------------|----|------|------|------|------------------------|------------|
| <i>Digitaria ischaemum</i>        | Poaceae         | t  | 2    | 1    | 1    | 1, 3                   | C          |
| <i>Digitaria sanguinea</i>        | Poaceae         | t  | 1.89 | 1.56 | 2.11 | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Diplachne fascicularis</i>     | Poaceae         | t  | 3    | 3    | 2    | 2                      | S          |
| <i>Duchesnea indica</i> *         | Rosaceae        | h  | 3    | 2    | -    | 1, 5, 6                | S          |
| <i>Echinochloa crus-galli</i>     | Poaceae         | t  | 2.36 | 2.44 | 2.04 | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, N, S |
| <i>Echinochloa eruciformis</i>    | Poaceae         | t  | 1    | 1    | -    | 6, 7                   | S          |
| <i>Echinocystis lobata</i> *      | Cucurbitaceae   | t  | 2.5  | 2.5  | 2    | 2, 3, 4, 6             | S          |
| <i>Echinophora tenuifolia</i>     | Apiaceae        | h  | -    | 1    | 2    | 2, 3                   | E          |
| <i>Eleusine indica</i> *          | Poaceae         | t  | 1.5  | 1.5  | 2    | 4, 5, 6                | C, S       |
| <i>Epilobium ciliatum</i> *       | Onagraceae      | h  | 2.33 | 2.5  | 3    | 5, 6, 7                | C, E       |
| <i>Epilobium hirsutum</i>         | Onagraceae      | h  | 2.5  | 2    | 1.5  | 2, 3, 4, 8             | S          |
| <i>Equisetum arvense</i>          | Equisetaceae    | g  | 2.18 | 2.45 | 1.18 | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, N, S |
| <i>Erigeron annuus</i> *          | Asteraceae      | u  | 3    | 2    | 2    | 1, 2, 3, 4, 5, 6, 7, 8 | S          |
| <i>Erodium cicutarium</i>         | Geraniaceae     | u  | 1    | 1    | 2    | 5                      | E          |
| <i>Euphorbia agraria</i>          | Euphorbiaceae   | h  | 2    | 2    | 1    | 1, 2, 5, 6             | E          |
| <i>Euphorbia heterophylla</i>     | Euphorbiaceae   | t  | 2    | 1    | 1    | 5                      | S          |
| <i>Euphorbia nutans</i> *         | Euphorbiaceae   | t  | 3    | 3    | 3    | 6                      | S          |
| <i>Euphorbia prostrata</i> *      | Euphorbiaceae   | t  | 2    | 2    | 2.5  | 5, 6, 7                | C, S       |
| <i>Euphorbia serpens</i>          | Euphorbiaceae   | t  | 3    | 2    | 1    | 5                      | S          |
| <i>Euphorbia virgata</i>          | Euphorbiaceae   | h  | 1    | 2    | 1    | 1, 2, 3, 4, 5, 6       | E          |
| <i>Fallopia convolvulus</i>       | Polygonaceae    | t  | 2    | 2.33 | 1.67 | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, S    |
| <i>Fumaria officinalis</i>        | Papaveraceae    | t  | 2.17 | 2    | 2.17 | 2, 4, 5                | E, N, S    |
| <i>Galeopsis pubescens</i>        | Lamiaceae       | t  | -    | 1    | 1    | 2                      | E          |
| <i>Galeopsis tetrahit</i>         | Lamiaceae       | t  | 1.71 | 1.86 | 2.29 | 1, 2, 3, 4, 5, 6       | E          |
| <i>Galinsoga ciliata</i> *        | Asteraceae      | t  | 2    | 1.67 | 2.5  | 2, 3, 4, 5             | C, S       |
| <i>Galinsoga parviflora</i> *     | Asteraceae      | t  | 2.56 | 2.6  | 2.2  | 2, 3, 4, 5, 6, 7       | E          |
| <i>Galium aparine</i>             | Rubiaceae       | t  | 2.21 | 2.42 | 2    | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, N, S |
| <i>Galium spurium</i>             | Rubiaceae       | t  | 2.5  | 2.5  | 1.5  | 2, 3, 4, 5             | E, S       |
| <i>Galium tricorutum</i>          | Rubiaceae       | t  | 1.67 | 2.33 | 2.33 | 2, 3, 4                | E, S       |
| <i>Geranium dissectum</i>         | Geraniaceae     | t  | 2    | 2    | 3    | 4                      | C          |
| <i>Geranium pusillum</i>          | Geraniaceae     | u  | 2    | 1.67 | 2    | 5, 6                   | E          |
| <i>Glycyrrhiza glabra</i>         | Fabaceae        | h  | 2    | 1    | 1    | 1, 2                   | S          |
| <i>Gypsophila muralis</i>         | Caryophyllaceae | t  | 3    | 2    | 1    | 1, 2, 5, 6, 7          | E          |
| <i>Helianthus annuus</i> *        | Asteraceae      | t  | 2.5  | 2.5  | 2    | 2, 3, 4, 5             | E          |
| <i>Helianthus tuberosus</i> *     | Asteraceae      | g  | 2.5  | 2    | 2    | 2, 3, 4, 8             | S          |
| <i>Heracleum lanatum</i> *        | Apiaceae        | h  | 3    | 3    | 2    | 6                      | N          |
| <i>Heracleum mantegazzianum</i> * | Apiaceae        | h  | 2.44 | 2.78 | 1.57 | 6, 8                   | C, N       |
| <i>Heracleum sosnowskyi</i>       | Apiaceae        | h  | 1    | 3    | 3    | 6                      | E          |
| <i>Heteranthera limosa</i> *      | Pontederiaceae  | a  | 2.5  | 2.5  | 1.5  | 2                      | E, S       |
| <i>Heteranthera reniformis</i> *  | Pontederiaceae  | a  | 2.67 | 2.33 | 1.33 | 2                      | E, S       |
| <i>Hibiscus trionum</i>           | Malvaceae       | t  | 2    | 1.67 | 1.67 | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Holcus mollis</i>              | Poaceae         | h  | 3    | 3    | 2    | 2, 6, 7                | S          |
| <i>Hordeum murinum</i>            | Poaceae         | t  | 3    | 3    | 2    | 1, 5, 6, 7             | E          |
| <i>Hypocoum imberbe</i>           | Fumariaceae     | t  | 2    | 1    | 1    | 2                      | S          |
| <i>Inula britannica</i>           | Asteraceae      | h  | *    | 3    | 1    | 5                      | C          |
| <i>Iva xanthifolia</i> *          | Asteraceae      | t  | 2.5  | 1.5  | 2    | 2, 3, 4, 5             | E, S       |
| <i>Juncus effusus</i>             | Juncaceae       | h  | 2    | 2.5  | 1.5  | 1, 2, 4                | E          |
| <i>Lactuca saligna</i>            | Asteraceae      | u  | 3    | 2    | 1    | 1, 2, 3, 4, 5, 6, 7, 8 | E          |
| <i>Lactuca serriola</i>           | Asteraceae      | u  | 1.75 | 2    | 1.75 | 1, 2, 3, 4, 5, 6, 7    | E, S       |

## Appendix 1. Continued.

| Species                            | Family           | LF | SPR  | WED  | CON  | Crop systems           | Regions    |
|------------------------------------|------------------|----|------|------|------|------------------------|------------|
| <i>Lamium amplexicaule</i>         | Lamiaceae        | u  | 2.5  | 2    | 2.5  | 5                      | E          |
| <i>Lamium purpureum</i>            | Lamiaceae        | t  | 2    | 1.75 | 1.75 | 2, 3, 4, 5, 6          | C, E       |
| <i>Lapsana communis</i>            | Asteraceae       | t  | 2    | 2.5  | 2    | 1, 2, 4, 5, 6, 7       | E, N       |
| <i>Lathyrus tuberosus</i>          | Fabaceae         | g  | 3    | 3    | 1    | 1, 2, 6, 7             | E          |
| <i>Lavatera cretica</i>            | Malvaceae        | u  | 3    | 3    | 1    | 6                      | S          |
| <i>Leersia oryzoides</i>           | Poaceae          | g  | 2.5  | 3    | 1.5  | 2                      | C, S       |
| <i>Lolium multiflorum</i>          | Poaceae          | h  | 1    | 2    | 1    | 2, 4                   | S          |
| <i>Lolium rigidum</i>              | Poaceae          | t  | 2.5  | 1.5  | 2    | 2, 6, 7                | S          |
| <i>Lotus tenuis</i>                | Fabaceae         | h  | 3    | 3    | 1    | 2, 4, 5, 6, 7          | E          |
| <i>Lysimachia punctata</i>         | Primulaceae      | h  | 1    | 1    | 3    | 1                      | E          |
| <i>Malva neglecta</i>              | Malvaceae        | u  | 2    | 2    | 1.5  | 1, 4, 5, 6             | E          |
| <i>Malva silvestris</i>            | Malvaceae        | u  | 3    | 3    | 3    | 1, 2, 5, 6, 7, 8       | S          |
| <i>Matricaria chamomilla</i>       | Asteraceae       | t  | 1.5  | 1.6  | 2.4  | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Matricaria inodora</i>          | Asteraceae       | u  | 2.36 | 2.55 | 2.18 | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, S    |
| <i>Matricaria matricarioides</i> * | Asteraceae       | t  | 3    | 2    | 2    | 2, 3, 4, 5, 6          | N          |
| <i>Matricaria perforata</i>        | Asteraceae       | t  | 2    | 1.67 | 1.33 | 1, 2, 3, 6, 8          | E          |
| <i>Melampyrum arvense</i>          | Scrophulariaceae | t  | 1    | 1    | 2    | 1                      | E          |
| <i>Mentha arvensis</i>             | Lamiaceae        | g  | 2    | 2    | 2    | 2                      | C          |
| <i>Mentha longifolia</i>           | Lamiaceae        | g  | 1    | 1    | 2    | 1, 6, 7                | E          |
| <i>Mercurialis annua</i>           | Euphorbiaceae    | u  | 1.33 | 1.67 | 2.33 | 4, 5, 6, 7             | C, E       |
| <i>Myosotis arvensis</i>           | Boraginaceae     | t  | 2.5  | 1.5  | 1    | 2, 3, 4                | C, E       |
| <i>Nardus stricta</i>              | Poaceae          | h  | 2    | 2.5  | 1.5  | 1                      | E, S       |
| <i>Nigella arvensis</i>            | Ranunculaceae    | t  | 2    | 1    | 1    | 2                      | S          |
| <i>Oenanthe spree</i>              | Apiaceae         | h  | 2    | 2    | 1    | 1                      | C          |
| <i>Orobanche aegyptica</i>         | Orobanchaceae    | t  | 3    | 3    | 2    | 5                      | S          |
| <i>Orobanche ramosa</i>            | Orobanchaceae    | t  | 3    | 3    | 2    | 5                      | S          |
| <i>Oryza sativa</i> *              | Poaceae          | t  | 3    | 3    | 1    | 2                      | S          |
| <i>Oxalis latifolia</i> *          | Oxalidaceae      | g  | 2    | 3    | 1    | 5                      | S          |
| <i>Oxalis pes-caprae</i> *         | Oxalidaceae      | g  | 2.5  | 2    | 1.5  | 2, 5, 6, 7             | S          |
| <i>Paliurus aculeatus</i>          | Rhamnaceae       | j  | 2    | 2    | 1    | 1                      | S          |
| <i>Panicum capillare</i> *         | Poaceae          | t  | 2.5  | 2    | 3    | 2, 3, 4, 5, 7          | S          |
| <i>Panicum dichotomiflorum</i> *   | Poaceae          | t  | 2.29 | 1.83 | 2    | 1, 2, 3, 4, 5, 6, 7    | C, S       |
| <i>Panicum miliaceum</i> *         | Poaceae          | t  | 2.67 | 3    | 1.67 | 2, 3, 4, 5             | C, E, S    |
| <i>Papaver rhoeas</i>              | Papaveraceae     | t  | 2.13 | 2.25 | 2    | 1, 2, 3, 4, 5, 6, 7    | C, E, N, S |
| <i>Parietaria officinalis</i>      | Urticaceae       | h  | 1    | 3    | 1    | 6                      | S          |
| <i>Paspalum dilatatum</i>          | Poaceae          | g  | 1    | 1    | 2    | 7                      | C          |
| <i>Paspalum distichum</i> *        | Poaceae          | h  | 1.67 | 2    | 1.5  | 1, 5, 6                | S          |
| <i>Pennisetum clandestinum</i>     | Poaceae          | h  | 2    | 3    | 1    | 5                      | S          |
| <i>Phalaris paradoxa</i>           | Poaceae          | t  | 2    | 2.33 | 2.33 | 1, 2, 5, 7             | N, S       |
| <i>Phleum pratense</i>             | Poaceae          | h  | 1    | 1    | 2    | 1, 2                   | S          |
| <i>Phlomis fruticosa</i>           | Lamiaceae        | n  | 3    | 3    | 1    | 1                      | S          |
| <i>Phragmites communis</i>         | Poaceae          | g  | 3    | 2    | 1    | 2, 3, 4, 5             | E, S       |
| <i>Picris echioides</i>            | Asteraceae       | u  | 2    | 3    | 2    | 3, 5                   | S          |
| <i>Plantago lanceolata</i>         | Plantaginaceae   | h  | 2    | 2    | 2    | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Plantago major</i>              | Plantaginaceae   | h  | 1    | 1    | 2    | 5                      | E          |
| <i>Poa annua</i>                   | Poaceae          | t  | 2.3  | 2    | 1.33 | 1, 2, 3, 4, 5, 6, 7    | C, E, N, S |
| <i>Poa palustris</i>               | Poaceae          | h  | 3    | 3    | 1    | 1, 2                   | N          |
| <i>Poa trivialis</i>               | Poaceae          | h  | 3    | 3    | 1    | 1, 2                   | N          |
| <i>Polygonum amphibium</i>         | Polygonaceae     | g  | 3    | 1    | 1    | 1, 5                   | E          |

## Appendix 1. Continued.

| Species                           | Family          | LF | SPR  | WED  | CON  | Crop systems           | Regions    |
|-----------------------------------|-----------------|----|------|------|------|------------------------|------------|
| <i>Polygonum aviculare</i>        | Polygonaceae    | t  | 2.09 | 2.18 | 1.82 | 1, 2, 3, 4, 5, 6, 7    | C, E, N, S |
| <i>Polygonum lapathifolium</i>    | Polygonaceae    | t  | 1.4  | 2    | 2.2  | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, S    |
| <i>Polygonum persicaria</i>       | Polygonaceae    | t  | 2.25 | 2.11 | 2.11 | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Portulaca oleracea</i> *       | Portulacaceae   | t  | 2.25 | 2.33 | 2.13 | 1, 2, 3, 4, 5, 6, 7, 8 | E, S       |
| <i>Prosopis farcta</i> *          | Fabaceae        | h  | 2    | 2    | 1    | 2                      | S          |
| <i>Pteridium aquilinum</i>        | Pteridiaceae    | g  | 2.57 | 3    | 1.29 | 1, 4, 6, 7, 8          | E, N, S    |
| <i>Ranunculus acris</i>           | Ranunculaceae   | h  | 3    | 3    | 1    | 1, 6                   | N          |
| <i>Ranunculus arvensis</i>        | Ranunculaceae   | t  | 2    | 2    | 2    | 1, 2, 6                | E          |
| <i>Ranunculus repens</i>          | Ranunculaceae   | h  | 2    | 2    | 1    | 1, 6                   | E, N       |
| <i>Raphanus raphanistrum</i>      | Brassicaceae    | t  | 2.17 | 2.33 | 2.67 | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Reynoutria japonica</i> *      | Polygonaceae    | g  | 2.62 | 2.46 | 1.15 | 2, 3, 4, 6             | C, N, S    |
| <i>Reynoutria sachalinensis</i> * | Polygonaceae    | g  | 2    | 2.5  | 1.67 | 2, 3, 4, 6             | C, N, S    |
| <i>Rorippa silvestris</i>         | Brassicaceae    | h  | 2    | 2    | 1    | 4, 5, 6                | E, N       |
| <i>Rubus caesius</i>              | Rosaceae        | n  | 3    | 2    | 1    | 1, 2, 4, 5, 6, 7, 8    | C          |
| <i>Rubus ulmifolius</i>           | Rosaceae        | n  | 2    | -    | 1    | 6, 7                   | S          |
| <i>Rudbeckia laciniata</i> *      | Asteraceae      | g  | 2    | 1    | 2    | 2, 3, 4                | S          |
| <i>Rumex acetosella</i>           | Polygonaceae    | h  | 2    | 2    | 1.5  | 1, 2, 3, 4, 5, 6, 7, 8 | S          |
| <i>Rumex bucephalophorus</i>      | Polygonaceae    | t  | 2    | 2    | 2    | 2, 6, 7                | S          |
| <i>Rumex conglomeratus</i>        | Polygonaceae    | h  | 2    | 3    | 2    | 1, 5, 6                | S          |
| <i>Rumex crispus</i>              | Polygonaceae    | h  | 2.6  | 2.4  | 1.4  | 1, 2, 3, 4, 5, 6, 7    | E, S       |
| <i>Rumex longifolius</i>          | Polygonaceae    | h  | 2.5  | 3    | 2    | 1                      | N          |
| <i>Rumex obtusifolius</i>         | Polygonaceae    | h  | 1.5  | 2.5  | 2    | 1, 5, 6                | E, S       |
| <i>Rumex pulcher</i>              | Polygonaceae    | h  | 2    | 3    | 2    | 1, 5, 6                | S          |
| <i>Sagina procumbens</i>          | Caryophyllaceae | c  | 2    | 2    | 2    | 5                      | C          |
| <i>Salsola kali</i>               | Chenopodiaceae  | t  | 3    | 3    | 1    | 2, 3, 7                | S          |
| <i>Salvia reflexa</i>             | Lamiaceae       | t  | 2    | 2    | -    | 1                      | E          |
| <i>Sanguisorba minor</i>          | Rosaceae        | h  | 1    | 1    | 2    | 1                      | E          |
| <i>Scandix pecten-veneris</i>     | Apiaceae        | t  | 2    | 2.5  | 2    | 1, 2, 3, 4, 5, 6, 7    | N, S       |
| <i>Scirpus maritimus</i>          | Cyperaceae      | g  | 1    | 2    | 1    | 2, 4                   | C          |
| <i>Scirpus mucronatus</i>         | Cyperaceae      | h  | 3    | 3    | 1    | 2                      | S          |
| <i>Scleranthus annuus</i>         | Caryophyllaceae | u  | 2    | 1.5  | 2.5  | 2, 3, 4                | E          |
| <i>Secale cereale</i>             | Poaceae         | u  | 2    | 3    | 2    | 2                      | S          |
| <i>Senecio inaequidens</i> *      | Asteraceae      | u  | 2.75 | 1.75 | 1.33 | 1                      | C, S       |
| <i>Senecio vernalis</i>           | Asteraceae      | u  | 2.67 | 1.33 | 1.5  | 1, 4                   | C, N       |
| <i>Senecio vulgaris</i>           | Asteraceae      | t  | 2.5  | 2.13 | 2.29 | 3, 4, 5, 6, 7, 8       | C, E       |
| <i>Setaria glauca</i>             | Poaceae         | t  | 2    | 2.14 | 2.14 | 1, 2, 3, 4, 5, 6, 7, 8 | E, S       |
| <i>Setaria verticillata</i>       | Poaceae         | t  | 2    | 2    | 2.33 | 1, 2, 3, 4, 5, 6, 7    | C, S       |
| <i>Setaria viridis</i>            | Poaceae         | t  | 2.13 | 2    | 2    | 1, 2, 3, 4, 5, 6, 7    | C, E, N, S |
| <i>Sicyos angulatus</i> *         | Cucurbitaceae   | t  | 3    | 1    | -    | 1, 2, 3                | S          |
| <i>Silene aegyptica</i>           | Caryophyllaceae | t  | 3    | 3    | 3    | 1, 2, 3, 4, 5, 6, 7    | S          |
| <i>Silybum marianum</i>           | Asteraceae      | u  | 2    | 2    | 2    | 2                      | S          |
| <i>Sinapis arvensis</i>           | Brassicaceae    | t  | 2    | 2.38 | 2.31 | 1, 2, 3, 4, 5, 6, 7, 8 | E, S       |
| <i>Sisymbrium altissimum</i>      | Brassicaceae    | u  | 1    | 1    | 3    | 2                      | E          |
| <i>Sisymbrium loeselii</i>        | Brassicaceae    | u  | 1    | 2    | 3    | 4                      | C          |
| <i>Sisymbrium officinale</i>      | Brassicaceae    | u  | 2    | 2    | 3    | 4                      | C          |
| <i>Solanum luteum</i>             | Solanaceae      | t  | 2    | 1    | 2    | 3, 4, 5                | E          |
| <i>Solanum nigrum</i>             | Solanaceae      | t  | 2.33 | 2.25 | 1.86 | 1, 2, 3, 4, 5, 6, 7, 8 | C, E, N, S |
| <i>Solanum physalifolium</i> *    | Solanaceae      | t  | 3    | 3    | 1    | 5                      | S          |
| <i>Solanum sarachoides</i> *      | Solanaceae      | t  | 1    | 1    | 2    | 5                      | C          |

## Appendix 1. Continued.

| Species                     | Family           | LF | SPR  | WED  | CON  | Crop systems           | Regions |
|-----------------------------|------------------|----|------|------|------|------------------------|---------|
| <i>Solanum tuberosum</i> *  | Solanaceae       | g  | 2    | 3    | 1    | 2, 4, 5                | N       |
| <i>Sonchus arvensis</i>     | Asteraceae       | h  | 2.31 | 2.08 | 1.54 | 1, 2, 3, 4, 5, 6, 7, 8 | E, N, S |
| <i>Sonchus asper</i>        | Asteraceae       | t  | 3    | 2    | 2    | 1                      | N       |
| <i>Sonchus oleraceus</i>    | Asteraceae       | t  | 3    | 2.5  | 2    | 1, 2, 3, 4, 5, 6, 7    | E, S    |
| <i>Sorghum bicolor</i> *    | Poaceae          | t  | 3    | 3    | 3    | 4                      | S       |
| <i>Sorghum halepense</i> *  | Poaceae          | h  | 2.5  | 2.52 | 1.81 | 1, 2, 3, 4, 5, 6, 7    | C, E, S |
| <i>Sorghum nigrum</i> *     | Poaceae          | t  | 3    | 2    | 2    | 2, 3, 4, 5             | S       |
| <i>Spergula arvensis</i>    | Caryophyllaceae  | t  | 1.5  | 2    | 2    | 2, 3, 4                | E       |
| <i>Stachys annua</i>        | Lamiaceae        | t  | 2    | 2    | 2    | 1, 2, 3, 4, 5, 6       | E       |
| <i>Stachys palustris</i>    | Lamiaceae        | g  | 2.5  | 2    | 1    | 2, 3, 4, 5             | E, N    |
| <i>Stellaria graminea</i>   | Caryophyllaceae  | h  | 2    | 2    | 2    | 2, 3                   | E       |
| <i>Stellaria media</i>      | Caryophyllaceae  | t  | 2.17 | 2.39 | 2    | 1, 2, 3, 4, 5, 6, 7    | E, N, S |
| <i>Symphytum officinale</i> | Boraginaceae     | h  | 2    | 1.5  | 2    | 1, 2, 4, 6             | C, E    |
| <i>Tagetes minuta</i> *     | Asteraceae       | t  | 2    | 2    | 2    | 7                      | C       |
| <i>Tanacetum vulgare</i>    | Asteraceae       | h  | 2    | 2    | 1    | 1, 2, 3, 6, 7, 8       | E       |
| <i>Taraxacum officinale</i> | Asteraceae       | h  | 2.4  | 2.3  | 1.3  | 1, 2, 3, 5, 6, 7, 8    | E, N, S |
| <i>Thlaspi arvense</i>      | Brassicaceae     | u  | 2    | 2    | 3    | 1, 2, 3, 4, 5, 6       | E       |
| <i>Torilis arvensis</i>     | Apiaceae         | t  | 3    | 2    | 1    | 6, 7                   | S       |
| <i>Trifolium arvense</i>    | Fabaceae         | u  | 1    | 2    | 2    | 1, 2                   | E       |
| <i>Tussilago farfara</i>    | Asteraceae       | g  | 1.5  | 2    | 1.5  | 1, 2, 4, 6, 7          | C, S    |
| <i>Typha latifolia</i>      | Typhaceae        | g  | 2    | 1.5  | 1.5  | 1                      | E       |
| <i>Urtica dioica</i>        | Urticaceae       | h  | 3    | 2    | 2    | 6                      | C       |
| <i>Urtica urens</i>         | Urticaceae       | t  | 2.29 | 2.57 | 2.33 | 1, 4, 5, 6, 7          | C, E, S |
| <i>Veratrum album</i>       | Liliaceae        | h  | 2    | 3    | 1    | 1, 6                   | E       |
| <i>Veronica hederifolia</i> | Scrophulariaceae | u  | 1    | 1    | 2    | 2                      | E       |
| <i>Veronica persica</i> *   | Scrophulariaceae | t  | 3    | 2.67 | 2.67 | 1, 2, 3, 4, 5, 6, 7    | E, S    |
| <i>Vicia cracca</i>         | Fabaceae         | h  | 3    | 2    | 1    | 2, 5                   | E       |
| <i>Vicia hirsuta</i>        | Fabaceae         | t  | 2    | 2.5  | 2    | 2, 3, 4, 5, 6, 7       | E       |
| <i>Vicia villosa</i>        | Fabaceae         | u  | 3    | 3    | 1    | 2, 6, 7                | E       |
| <i>Viola arvensis</i>       | Violaceae        | u  | 2.22 | 2.22 | 1.78 | 2, 3, 4, 5, 6          | C, E, N |
| <i>Viola tricolor</i>       | Violaceae        | u  | 1    | 2    | 2.5  | 1, 2, 4, 5             | E, S    |
| <i>Vulpia myuros</i>        | Poaceae          | t  | 2    | 2    | 2    | 2                      | S       |
| <i>Vulpia unilateralis</i>  | Poaceae          | t  | 2    | 2    | 1    | 2                      | S       |
| <i>Xanthium italicum</i> *  | Asteraceae       | t  | 3    | 2.5  | 1.8  | 1, 2, 3, 4, 5, 6, 7    | E, S    |
| <i>Xanthium spinosum</i> *  | Asteraceae       | t  | 2    | 1.33 | 1.67 | 1, 2, 3, 4, 5          | E, S    |
| <i>Xanthium strumarium</i>  | Asteraceae       | t  | 2.36 | 2.27 | 1.5  | 1, 2, 3, 4, 5, 6       | E, S    |

LF = life form: a aquatic plant, c chamaephyte, g geophyte, h hemicryptophyte, j shrub, n small shrub, p vine, u biennial. SPR = mean score for spread potential (1 minimum, 3 maximum), WED = mean score for weediness (1 minimum, 3 maximum), CON = mean score for control success (1 minimum, e.g. difficult to control; 3 maximum, e.g. easy to control). CULT = number of culture systems in which species occurs. For definition of crop systems see text. \* indicates that the species is alien to Europe. Crop systems refer to the systems for which species has been listed: 1 fodder plants and pastures, 2 cereals, 3 grain legumes, 4 root crops, 5 vegetables and ornamentals, 6 orchards, 7 vineyards, 8 other agricultural areas. Regions refers to the following regions in which the species has been listed: C Central Europe (Austria, France, Germany, The Netherlands), N Northern Europe (British Isles, Denmark, Finland, Norway, Sweden), E Eastern Europe (Bulgaria, Czech Republic, Hungary, Lithuania, Poland, Romania, Slovakia, Ukraine), S Southern Europe (Albania, Cyprus, Greece, Italy, Portugal, Spain, Turkey, Slovenia, Croatia).