Pak. J. Weed Sci. Res. 17(1): 83-101, 2011

PRELIMINARY INVENTORY OF THE SPECIES ASSOCIATED TO *Sulla coronaria* (L.) MEDIK. (FABACEAE) IN NORTHEASTERN ALGERIA

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ABSTRACT

In the framework of the evaluation and valorization of plant genetic resources of fodder and pastoral interest in Algeria, a preliminary inventory of the species associated to Sulla coronaria (L.) Medik. (Syn. Hedysarum coronarium L.; Fabaceae) has been undertaken throughout the North East of the country. The inventory has been conducted on 13 sites. Two ecological factors (rainfall and altitude) of the environment of origin of the plants have been taken into account. The 73 genera and 106 species constituted by forages and weeds, respectively have been identified. Fodder grasses and legumes have been noticed (18 genera and 40 species). Numerous weeds have also been encountered (55 genera and 66 species). Our observations have indicated the existence of real potential of adaptation of different species to the same environment. The results also showed that many species can adapt to different ecological conditions. Interesting natural associations between legumes and grasses have been met which will permit to constitute various interesting mixtures (in situ and ex situ) for development of livestock. This study would contribute to develop a strategy for regenerating, preserving, protecting and valorizing meadows in Algeria.

Key words: Ecological factors, forages, grasses, legumes, meadows, plant genetic resources, *Sulla,* weeds.

INTRODUCTION

The isoclimatic Mediterranean zone occupies 14 millions km^2 in 50 countries and five continents. It harbors some 74,000 species of vascular plants of which 39,000 are endemic to one country or subzone; the number of legumes is about 10% of the overall flora (Le Houérou, 2001).

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Algeria, a North African country, spreads over 2.4 million km^2 running from east to west along the Mediterranean Sea over 1200 km, pushing from the north to the south over more than 2000 Km at the heart of the great desert of the Sahara (DGF, 1998). A set of ecosystems coexisting throughout Algerian territory: marine, coastal and freshwater ecosystems from one hand and forest, mountainous, semi-arid and arid ecosystems on the other hand, the last represent about 80% of the whole area (DGF, 1998). The physical configuration is expressed by a latitudinal zone characterized by the existence of climate on which the Mediterranean influence decreases as far as we move away from the sea: humid (900-1800 mm/year), sub humid (800-900mm/year), semi arid (300-600 mm/year), arid (100-300 mm/year) and Saharian (less than 100 mm/year). We note, besides this, a rainfall gradient from west to east, the oriental band is distinctly wettest (DGF, 1998).

Throughout this territory, the Algerian flora contains 3139 species (Quezel and Santa, 1962), among which the forage legumes are represented by 33 genera comprising about 293 species (Issolah and Beloued, 2005). According to Ozenda (1977), the Saharian flora appears to be poor if we compare the small number of species met in desert and the huge surface that it covers.

Hedysarum coronarium L., commonly called Sulla and recently reclassified by Choi and Ohashi (2003) as *Sulla coronaria* (L.) Medik., is one of the most important natural forage legumes in Mediterranean areas (Flores *et al.,* 1997) which originated from the Mediterranean where it is widely used as hay, silage and green forage (Douglas, 1984). It is a biennial fodder species, sometimes perennial (Villax, 1963) considered by Flores *et al.* (1997) as an annual or biennial crop, lasting from one to three years in good cultivation conditions. It is also an ornamental and honey plant.

The agronomical features of this legume are: remarkable productivity in mild winter when other forages (for example *Medicago sativa* L.) are dormant; drought resistance due to its xerophytic habit; large adaptability to poor soils (Flores *et al.,* 1997). *Sulla* crop presents a potential interest in the north of Morocco where erosion problem prevails (Thami-Alami, 1990). In *Hedysarum*, little is known about the taxonomic relationships of the different taxa (Baatout *et al.,* 1991a) and about the nature of genetic variability in diploid species (Baatout *et al.,* 1991b).

A cytogenetic study revealed the existence of different chromosome numbers in Algerian populations of *Hedysarum coronarium* L. The first one (2n = 16) is usually cited, whereas the second one (2n = 18) has been recently observed within this species (Issolah *et al.,* 2006).

The objective of the present work is to determine the species which grow with *Sulla* in order to elaborate a strategy for the preservation, the protection and valorization of plant genetic resources of fodder and pastoral interest. This will permit also to know more about the ecosystem of *Sulla coronaria*. The most interesting natural populations would be selected for regenerating meadows, *in situ* and *ex situ*, particularly in the isolated areas of the country, for developing livestock and improving the life level and socio-economic status of the local farming communities. The said study follows the research work conducted on spontaneous fodder legumes in Algeria (Issolah *et al.,* 1993; Issolah and Abdelguerfi, 1995; Issolah and Abdelguerfi, 1999a; Issolah and Abdelguerfi, 1999b; Issolah and Abdelguerfi, 2000; Issolah *et al.,* 2001; Issolah and Abdelguerfi, 2003; Issolah and Abdelguerfi, 2004; Issolah *et al.* 2006; Issolah and Khalfallah, 2007; Issolah and Yahiaoui, 2008; Issolah and Abdelguerfi, 2010; Issolah and Khalfallah, 2010).

MATERIALS AND METHODS

Collect missions were undertaken by the National Institute of Agronomic Research of Algeria (INRAA) in 1998 through the Northern East of the country. Several sites of *Sulla coronaria* (L.) Medik. (Syn. *Hedysarum coronarium* L.) were located. Thirteen sites (Fig. 1) were subjected to a preliminary inventory of species associated to Sulla using the flora of Algeria (Quezel and Santa, 1962). The size of sites was variable from one area to other. On each site, the recognition of the species was realized over the whole area occupied by *Sulla coronaria* (L.) Medik. (Syn. *Hedysarum coronarium* L.).

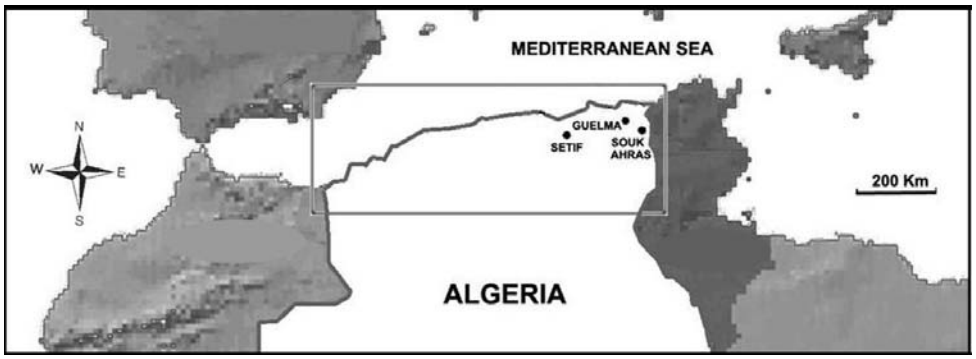

Figure 1. Location of several sites of *Sulla coronaria* (L.) Medik. in Northeastern Algeria.

We took also in count the ecological factors (altitude and rainfall) of the natural habitat (ANRH, 1993) of *Sulla* (Table-1).

Table-1. Ecological characteristics of thirteen (13) sites corresponding to the environment of origin of *Sulla coronaria* (L.) Medik. in Algeria (Issolah *et al.*, 2006 completed; Issolah and Khalfallah, 2007).

N° du site	Origine	Altitude (m)	Rainfall (mm)
8/98	Sétif	740	564
9/98	Sétif	765	564
10/98	Sétif	830	564
11/98	Sétif	870	-
12/98	Sétif	960	665
13/98	Sétif	1030	600
16/98	Guelma	120	700
17/98	Guelma	200	-
21/98	Guelma	400	600
22/98	Guelma	500	600
23/98	Guelma	1060	600
26/98	Souk Ahras	840	700
27/98	Souk Ahras	480	700

RESULTS AND DISCUSSION

During the collect missions conducted through the North East of Algeria, *Sulla coronaria* was encountered at variable altitudes and relatively variable rainfall. For each site, the inventory permitted to record many species existing in association with Sulla (Appendix-I).

All of the recorded plant genetic resources correspond to 73 genera and 106 species including forages and weeds.

Among all of these plants, eighteen genera comprising forty forage species associated to *Sulla* were determined (Issolah *et al.,* 2001). In terms of the richness of genera in species (legumes and grasses), it was noted, in decreasing order: *Trifolium* (10 species); *Medicago* (06 species); *Astragalus* (03 species), *Phalaris* (03 species) and *Scorpiurus* (02 species).

In this framework, we pointed out the predominance of legumes as compared to grasses and also highlighted the importance of the forage associations and the role which they can play. The distribution of forage species and their frequency according to the ecological factors (altitude and rainfall) of the environment of origin was also studied. The most frequent species, in decreasing order are *Scorpiurus muricatus* L. (6 times), *Lolium rigidum* Gaud. (5 times), *Avena sterilis* L. (4 times), *Medicago hispida* Gaertn. (4 times), *Phalaris paradoxa* L. (4 times) and *Trifolium angustifolium* L. (4 times) (Table-2).

Table-2. Frequency of forage species associated to *Sulla coronaria* (L.) Medik. (Issolah *et al.*, 2001) in Algeria.

Species	Frequency of the species on the prospected sites (13)
Astragalus caprinus L.	1/13
Astragalus hamosus L.	2/13
Astragalus sesameus L.	1/13
Avena sterilis L.	4/13
Carthamus caeruleus L.	1/13
Dactylis glomerata L.	1/13
Festuca elatior L.	1/13
Hedysarum pallidum Desf.	3/13
Hedysarum sp.	1/13
Hordeum bulbosum L.	1/13
Leontodon hispidulus (Del.) Boiss.	3/13
Lepturus cylindricus (Willd.) Trin.	1/13
Lolium multiflorum Lamk.	3/13
Lolium rigidum Gaud.	5/13
Lotus ornithopodioides L.	2/13
Medicago ciliaris Krock.	3/13
Medicago hispida Gaertn.	4/13
Medicago lupulina L.	1/13
Medicago murex Willd.	3/13
Medicago orbicularis (L.) All.	3/13
Medicago sativa L.	1/13
Onobrychis Caput galli Lamk.	1/13
Phalaris brachystachys Link.	2/13
Phalaris caerulescens Desf.	1/13
Phalaris paradoxa L.	4/13
Picris echioides L.	2/13
Scorpiurus muricatus L.	6/13
Scorpiurus vermiculatus L.	1/13
Sonchus oleraceus L.	1/13
Sulla coronaria (L.) Medik.	13/13
Trifolium angustifolium L.	4/13
Trifolium lappaceum L.	1/13
Trifolium pallidum W. et Kit.	1/13
Trifolium pratense L.	1/13
Trifolium resupinatum L.	2/13
Trifolium scabrum L.	3/13
Trifolium tomentosum L.	2/13
Trifolium squarrosum L.	1/13
Trifolium stellatum L.	1/13
Trifolium striatum L.	1/13

The rainfall varies weakly in the prospected sites (564 mm – 700 mm). On the contrary, the altitude is very variable (120 m – 1060 m). The study of the distribution of forage species which exist, at least, on three sites, has established the following facts (Table-3).

Hedysarum coronarium, Scorpiurus muricatus and Lolium rigidum, which are the most frequent species, were encountred in the areas of variable altitude (weak, average, high). *Trifolium angustifolium, Phalaris paradoxa, Leontodon hispidulus, Medicago hispida, Medicago murex, Trifolium scabrum* and *Lolium multiflorum* have been encountered in the average and high altitude areas. Whereas, *Avena sterilis, Hedysarum pallidum, Medicago ciliaris* and *Medicago orbicularis* were encountered in the high altitude areas.

On the basis of Algerian flora (Quezel and Santa, 1962), an analysis of generic classification of forage legumes (33 genera) allowed to classify the genus *Hedysarum* L. (09 species) at the 8th position, after *Astragalus* L. (40 species), *Trifolium* L. (37 species), *Ononis* (34 species), *Vicia* L. (26 species), *Lathyrus* (Tourn.) L. (22 species), *Medicago* L. (22 species) and *Lotus* L. (15 species) respectively (Issolah and Beloued, 2005).

According to Abdelguerfi-Berrekia *et al.,* (1991), *Hedysarum coronarium* appears to be limited to the east of Algeria and grows mainly in well watered areas. It is more common in the regions where rainfall exceeds 650 mm and has not been met at less than 450 mm. Abdelguerfi-Berrekia *et al.,* (1991) indicated that this species was generally found at varying altitudes, below 460 m. They reported the presence of *Hedysarum coronarium* (21 records) on soils of fine to medium texture, with very low to medium conductivity, generally poor in potassium and total limestone. Results also showed that *H. aculeolatum*, *H. flexuosum* and to a lesser degree *H. coronarium* were less frequent when the content of soil with total limestone is very high. Similarly, *H. flexuosum* and *H. coronarium* were met less often when the soil texture becomes coarser (Abdelguerfi-Berrekia, 1991).

For a better and complete knowledge of the different parameters which constitute the ecosystem of *Sulla*, the different species of weeds (Table-4) were also identified. The 55 genera and 66 species were determined. In this case, the most frequent species were, in decreasing order: *Daucus carota* (10 times), *Cichorium inthybus* (07 times), *Anacyclus clavatus* (06 times), *Centaurea nicaensis* (05 times). No genus has been distinguished by the number of species it contains. The relatively richest genera encountered were *Bromus*, *Centaurea* and *Plantago* only with 3 species each.

Table-3. Distribution of the forage species (frequency ≥ 3 sites) throughout the different sites of *Sulla coronaria* (L.) Medik. in Algeria.

N° of site	*Sulla Coronaria*	*Scorpiurus muricatus*	*Lolium Rigidum*	*Trifolium Angustifolium*	*Phalaris paradoxa*	*Avena sterilis*	*Medicago Hispida*	*Hedysarum pallidum*	*Leontodon hispidulus*	*Lolium multiflorum*	*Medicago Ciliaris*	*Medicago murex*	*Medicago orbicularis*	*Trifolium Scabrum*
8/98	*	*		*			*			*				
9/98	*	*				*		*			*			
10/98	*	*	*	*	*		*	*			*	*	*	
11/98	*		*				*	*	*		*	*		*
12/98	*		*		*	*							*	
13/98	*				*	*							*	
16/98	*	*												
17/98	*		*											
21/98	*						*					*		*
22/98	*	*		*					*	*				*
23/98	*					*			*	*				
26/98	*													
27/98	*	*	*	*	*									

Table-4. Frequency of the different species of weeds associated to *Sulla coronaria* (L.) Medik. in Algeria.

Species of weeds	Frequency of weeds On the sites (13) of *Sulla*
Adonis dentata Del.	1/13
Aegilops triuncialis L. ssp. *eu-ovata* Eig.	1/13
Ammi majus L.	1/13
Anacyclus clavatus (Desf.)	6/13
Anagallis arvensis L.	2/13
Anchusa sp.	2/13
Borago officinalis L.	2/13
Brachypodium distachyum (L.) P. B.	1/13
Brachypodium sylvaticum (Huds) P. B.	2/13
Brassica rapa L.	1/13
Bromus hordaceus L.	1/13
Bromus madritensis L.	1/13
Bromus rubens L.	1/13
Calendula arvensis L.	1/13
Calicotum spinosa (L.) Lamk	2/13
Carduus tenuiflorus Curt.	2/13
Catananche lutea L.	1/13
Celsia cretica L.	1/13
Centaurea algeriensis Coss. et . Dur.	1/13
Centaurea calcitrapa L.	1/13
Centaurea nicaensis All.	5/13
Cerinthe major L.	1/13
Cichorium intybus L.	*7/13*
Convolvulus arvensis L.	*1/13*
Convolvulus tricolor L.	*1/13*
Daucus carota L.	10/13
Echinops spinosus L.	1/13
Echium plantagineum L.	1/13
Eryngium campestre L.	1/13
Ferula communis L.	1/13
Foenicum vulgare (Mill.) Gaertn.	1/13
Galactites tomentosa (L.) Moench.	4/13
Galium mollugo L.	1/13
Genista tricuspidata Desf.	1/13
Hirchsfeldia incana (L.) *lagrese* ssp. *geniculata* (Desf.) M.	1/13
Inula viscosa (L.) Ait.	1/13
Hordeum murinum L.	1/13

Species of weeds	**Frequency of weeds On the sites (13) of *Sulla***
Lavatera trimestris L.	1/13
Linum usitatissimum L. ssp. *angustifolium* L. (Huds.) Fiori.	1/13
Linum strictum L.	2/13
Lithospermum apulum (L.) Vahl.	1/13
Lithospermum arvense L.	1/13
Lythrum junceum Soland.	1/13
Malope malachoides L.	1/13
Mantisalca salmantica (L.) Briq. et Cavill.	2/13
Muscari comosum (L.) Mill.	1/13
Nigella damascena L.	1/13
Ononis minutissima L.	1/13
Ornithogalum pyramidale L.	3/13
Pallenis spinosa (L.) Cass.	7/13
Pärentucelia viscosa L.	1/13
Phlomis sp.	1/13
Plantago lagopus L.	4/13
Plantago psyllium L.	1/13
Plantago sp.	1/13
Ptychotis verticillata	1/13
Rapistrum rugosum (L.) All.	5/13
Reseda alba L.	2/13
Rhagadiolus stellatus Wild.	1/13
Salvia verbenaca Batt.	2/13
Scabiosa atropurpurea L. ssp. *maritima* (L.) Fiori et Paol.	4/13
Scabiosa stellata L.	2/13
Scolymus hispanicus L.	1/13
Sherardia arvensis L.	1/13
Silene sp.	1/13
Verbascum sinuatum L.	2/13

The inventory of plant genetic resources associated with *Sulla coronaria* (L.) Medik. (Syn. *Hedysarum coronarium* L.) permitted to highlight an important biodiversity between forages (legumes, grasses) and weeds. *Sulla* presented also two types of populations: there were prostrate populations adapted to grazing and erect strains adapted to mowing. The leaf /stem ratio, and therefore forage quality, varies widely from one population to the next (Le Houérou, 1979). The Algerian populations of *Sulla* which come from high altitude areas were

characterized by a weak vegetative development (Issolah *et al.,* 2001).

The previous study indicated that the altitude intervenes on four morphological characteristics of *Sulla* (weight of seeds, end of the bloom, appearance of the first fruiting head, full fruiting heads) whereas the rainfall intervenes only on two characteristics (rate of the seedling at the second simple leaf, end of the bloom). Only one characteristic (end of the bloom) was influenced by both altitude and rainfall. The altitude would constitute the most important ecological factor for its influence on the morpho-physiological variation of the Algerian populations within *H. coronarium* (Issolah and Khalfallah, 2007).

In Algeria, rainfall, altitude, the total limestone content of the soil and soil texture (clay content) were the most determining elements on the presence or lack of certain species of the genus *Hedysarum* as well as their distribution; in some species of this genus, rainfall and altitude factors have net effects on variation of certain characteristics, particularly in *H. coronarium* and *H. glomeratum*; certain populations have strongly endured influence of origin environment and the selection and the formation of ecotypes seems obvious (Abdelguerfi, 2001).

Within the same family (*Fabaceae*), the morphological variability observed in several Algerian species of the genus *Trifolium* (Issolah *et al.,* 1993) is linked to certain ecological factors (altitude, rainfall, longitude, latitude) of the originating environment of the populations. According to Negri and Veronesi (1987), Italian populations of white clover coming from higher altitudes showed a low degree of spring re-growth and later bloom date.

Interesting natural associations have also been met between legumes and grasses through this study which will permit to constitute various interesting mixtures for development of livestock. Concerning the interest of the association Oat-Sulla, in Tunisian Sub-Humid zone, it was established that the most important yields of dry matter were obtained with the association Oat-Sulla (8.83 t D.M / ha – 9.92 t D.M / ha) whereas the association Vetch-Oat could give only relatively weak yields (4.87 t D.M ha^{-1} – 4.93 t D.M ha^{-1}). Results revealed that the vetch Villosa seems to be a weak partner for Oat in the Tunisian sub-humid zone; in turn, the Sulla has been observed to be more vigorous and more productive in association with Oat (Ben Taamallah, 1987).

The use of meadows of perennial legumes as forage is widespread in Mediterranean environment, and the species most utilized are sainfoin (*Onobrychis viciifolia* Scop.) and French honey-suckle (*Hedysarum coronarium* L.) (Martiniello and Ciola, 1994). Improved genotypes, well adapted to the environment and with high

seed quality, are required (Martiniello and Ciola, 1994). Studies on agronomic factors influencing the adaptability of the varieties and ecotypes could be useful for determining agronomic techniques to increase seed production (Martiniello and Ciola, 1994).

Grasses would be at an advantage in a series of favourable seasons, but legumes, with their persistent seed bank, would be an advantage in a more variable environment, where they may be a total failure in seed set. Efforts aimed to increase the legume content of the pasture would result not only in reduced plant competition for nitrogen and increased feed quality, but would also ensure a more persistent seed bank and so give greater long-term stability of grassland productivity (Russi *et al.,* 1992a). When degraded grasslands need to be re-sown because of overgrazing, small-seeded species or varieties should be chosen, since these species are more persistent under heavy grazing throughout the summer (Russi *et al.,* 1992b).

In the *Fabaceae* family, it is important to note that in general, the Algerian populations belonging to the genus *Trifolium*, have lighter seeds compared to those of the genera *Medicago*, *Hedysarum* and especially *Scorpiurus* (Issolah, 1997). In the genus *Trifolium*, a study of 12 wild species in Algeria, has indicated that *T. striatum*, *T. spumosum* and *T. fragiferum* are characterized by heavier seeds compared to those of *T. bocconei*, *T. campestre* and *T. arvense* (Issolah and Abdelguerfi, 1995). Others results have shown positive relationships between the thousand seeds weight and the altitude of the natural habitat in several natural populations of *T. campestre*, *T. resupinatum*, *T. scabrum* (Issolah and Abdelguerfi, 1995) and *Hedysarum coronarium* (Issolah and Khalfallah, 2007).

In Algeria, the production of fodder is extensive (Houmani, 1999; Issolah, 2008). The efficiency of fodder production transformation as animal products depend on the quality and quantity of consumed fodder (Ben Tamallah, 1987). Our study allowed to have a clear idea on the species that frequently grow with *Sulla*, and hence reflect on a development strategy to regenerate, preserve, protect and valorize the meadows, *in situ* and *ex situ*, with species characterized by similar aptitudes of adaptation, specially those presenting both economical (forage, honey plant, ornamental plant) and environmental (protection against soil erosion) interest. This would also permit to develop the most isolated and deprived areas throughout the country.

The key issues for protecting valuable genetic resources of fodder legumes in the future are conservation (*in situ and ex situ*) and management; ideal action in the isoclimatic arid and semiarid Mediterranean zone will have to consider production and protection simultaneously (Le Houérou, 2001).

Appendix-I. Identification of the species in thirteen (13) sites of the environment of origin of *Sulla coronaria* (L.) Medik. in Algeria.

N° of Site	Name of the species
8/98	*Anacyclus clavatus (W)* *Carduus tenuiflorus* (W) *Cichorium intybus* (W) *Foenicum vulgare* (W) *Hedysarum* sp. (F) *Lolium multiflorum* (F) *Medicago hispida* (F) *Scorpiurus muricatus* (F) *Sulla coronaria* (F)(Syn. *Hedysarum coronarium*) *Trifolium angustifolium* (F)
9/98	*Aegilops triuncialis* ssp. *eu-ovata* Eig. (W) *Avena sterilis* (F) *Centaurea nicaensis* (W) *Convolvulus arvensis* (W) *Galactites tomentosa* (W) *Hedysarum pallidum* (F) *Lavatera trimestris* (W) *Linum strictum* (W) *Lithospermum apulum* (W) *Medicago ciliaris* (F) *Nigella damascena* (W) *Pallenis spinosa* (W) *Phlomis sp.* (W) *Plantago psyllium* (W) *Rapistrum rugosum* (W) *Scorpiurus muricatus* (F) *Sulla coronaria* (F)*(Syn. Hedysarum coronarium)*
10/98	*Anagallis arvensis* (W) *Anchusa* sp. (W) *Calendula arvensis* (W) *Calicotum spinosa Lam.* (W) *Centaurea nicaensis* (W) *Cichorium intybus* (W) *Daucus carota* (W) *Galectites tomentosa* (W) *Galium mollugo* (W) *Hedysarum pallidum* (F) *Hirchsfeldia incana* (L.) *lagrese* ssp. *geniculata* (Desf.) M. (W) *Lolium rigidum* (F) *Lotus ornithopodioides* (F) *Medicago ciliaris* (F) *Medicago hispida* (F) *Medicago murex* (F) *Medicago orbicularis* (F)

	Onobrychis caput galli (F)
	Ornithogalum pyramidale (W)
	Pallenis spinosa (W)
	Phalaris brachystachys (F)
	Phalaris paradoxa (F)
	Plantago Lagopus (W)
	Ptychotis verticillata (W)
	Rapistrum rugosum (W)
	Reseda alba (W)
	Scabiosa atropurpurea L. ssp. *maritima* (L.) Fiori et Paol. (W)
	Scorpiurus muricatus (F)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)
	Trifolium angustifolium (F)
	Verbascum sinuatum (W)
	Anacyclus clavatus (W)
	Anagallis arvensis (W)
	Brachypodium distachyum (W)
	Brachypodium sylvaticum (W)
	Bromus rubens (W)
	Cichorium intybus (W)
	Dactylis glomerata (F)
	Daucus carota (W)
	Eryngium campestre (W)
	Genista tricuspidata (W)
	Hedysarum pallidum (F)
	Hordeum murinum (W)
11/98	*Leontodon hispidulus* (F)
	Linum strictum (W)
	Lolium rigidum (F)
	Medicago hispida (F)
	Medicago lupulina (F)
	Medicago murex (F)
	Mantisalca salmantica (W)
	Pallenis spinosa (W)
	Reseda alba (W)
	Scabiosa atropurpureasous ssp. *maritima* (W)
	Scabiosa stellata (W)
	Scorpiurus vermiculatus (F)
	Silene sp. (W)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)
	Trifolium scabrum (F)
	Ammi majus (W)
	Anchusa sp. (W)
	Anacyclus clavatus (W)
	Avena sterilis (F)
	Borago officinalis (W)
	Bromus madritensis (W)
	Carthamus caeruleus (F)
	Cichorium intybus (W)

	Convolvulus tricolor (W)
	Daucus carota (W)
	Ferula communis (W)
	Lolium rigidum (F)
12/98	*Medicago ciliaris* (F)
	Medicago orbicularis (F)
	Mantisalca salmantica (W)
	Ornithogalum pyramidale (W)
	Phalaris brachystachys (F)
	Phalaris paradoxa (F)
	Picris echioides (F)
	Plantago sp. (W)
	Rhagadiolus stellatus (W)
	Sherardia arvensis (W)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)
	Astragalus hamosus (F)
	Astragalus sesameus (F)
	Avena sterilis (F)
	Brassica rapa (W)
	Calicotum spinosa (W)
	Carthamus caeruleus (F)
	Centaurea nicaensis (W)
	Cichorium intybus (W)
	Daucus carota (W)
	Festuca elatior (F)
13/98	*Linum usitatissimum* ssp. *angustifolium* L. (Huds.) Fiori. (W)
	Lotus ornithopodioides (F)
	Lythrum junceum (W)
	Medicago orbicularis (F)
	Muscari comosum (W)
	Phalaris paradoxa (F)
	Rapistrum rugosum (W)
	Sonchus oleraceus (F)
	Scabiosa stellata (W)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)
	Trifolium pratense (F)
	Trifolium resupinatum (F)
	Trifolium squarrosum (F)
	Centaurea nicaensis (W)
	Cerinthe major (W)
	Centaurea algeriensis (W)
	Echium plantagineum (W)
16/98	*Hordeum bulbosum* (F)
	Malope malachoides (W)
	Pallenis spinosa (W)
	Scorpiurus muricatus (F)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)

	Anacyclus clavatus (W)
	Celsia cretica (W)
17/98	*Daucus carota* (W)
	Inula viscosa (W)
	Lolium rigidum (F)
	Ononis minutissima (W)
	Pallensis spinosa (W)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)
	Astragalus hamosus (F)
	Centaurea calcitrapa (W)
	Cichorium intybus (W)
	Daucus carota (W)
	Galactites tomentosa (W)
	Medicago murex (F)
	Medicago hispida (F)
21/98	*Plantago lagopus* (W)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)
	Trifolium pallidum (F)
	Trifolium resupinatum (F)
	Trifolium scabrum (F)
	Trifolium striatum (F)
	Trifolium tomentosum (F)
	Verbascum sinuatum (W)
	Brachypodium sylvaticum (W)
	Centauria nicaensis (W)
	Cichorium intybus (W)
	Daucus carota (W)
	Echinops spinosus (W)
	Lolium multiflorum (F)
22/98	*Leontodon hispidilus* (F)
	Lepturus cylindricus (F)
	Pallenis spinosa (W)
	Plantago lagopus (W)
	Scolymus hispanicus (W)
	Scorpiurus muricatus (F)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)
	Trifolium scabrum (F)
	Trifolium angustifolium (F)
	Astragalus caprinus (F)
	Avena sterilis (F)
	Catananche lutea (W)
	Daucus carota (W)
	Leontodon hispidulus (F)
	Lolium multiflorum (F)
23/98	*Medicago sativa* (F)
	Ornithogalum pyramidale (W)
	Phalaris caerulescens (F)
	Trifolium stellatum (F)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)

	Adonis dentata (W)
	Anacyclus clavatus (W)
	Borago officinalis (W)
	Bromus hordaceus (W)
	Centaurea nicaensis (W)
	Galactites tomentosa (W)
26/98	*Pallenis spinosa* (W)
	Plantago lagopus (W)
	Rapistrum rugosum (W)
	Salvia verbenaca (W)
	Scabiosa atropurpurea ssp. *maritima* (L.) Fiori et Paol. (W)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)
	Anacyclus clavatus (W)
	Carduus tenuiflorus (W)
	Centaurea nicaensis (W)
	Daucus carota (W)
	Lithospermum arvense (W)
	Lolium rigidum (F)
	Pallenis spinosa (W)
	Pärentucelia viscosa (MH)
27/98	*Picris echioides* (F)
	Phalaris paradoxa (F)
	Rapistrum rugosum (W)
	Salvia verbenaca (W)
	Scabiosa atropurpurea ssp*. maritime* (L.) Fiori et Paol. (W)
	Scorpiurus muricatus (F)
	Sulla coronaria (F)(Syn. *Hedysarum coronarium*)
	Trifolium angustifolium (F)
	Trifolium lappaceum (F)
	Trifolium tomentosum (F)

F: Forages; W: Weeds

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