Occurrence of Biotic Harmful Agents in Czech Grass Seed Production (1995–2004)

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Abstract

Cagaš B., Macháč J., Frydrych J., Macháč R. (2006): **Occurrence of biotic harmful agents in Czech grass seed production (1995–2004)**. Plant Protect. Sci., **42**: 58–65.

In the years 1995–2004 the spectra of weeds, diseases and pests in grasses grown for seed in the Czech Republic were examined and the effect of external factors on their changes was assessed. The species spectrum of weeds evaluated both at the time of vegetation and in samples of natural seeds was stable throughout the period and the changes in the number of individual species were caused by different proportions of grass species and stand age. The most abundant weeds were *Elytrigia repens, Matricaria* sp.div., *Anthemis* sp.div., *Apera spica-venti, Cirsium arvense, Poa trivialis, Rumex* sp.div. and *Chenopodium* sp.div. The most serious diseases were parasitic silvertop, graminicolous rusts (*Puccinia* sp.div.), *Blumeria graminis* and ergot (*Claviceps purpurea*). The rate of rust occurrence was affected by climatic conditions; the spectrum of other diseases was stable throughout this period. The most important animal pests were *Muridae* rodents.

Keywords: grass seed; weeds; diseases; pests; external conditions

Grass seed growing in the Czech Republic is a minor but relatively stable branch of plant production with a high proportion of export. In the last 10 years this branch has undergone many changes. The fundamental changes are the decrease in seed propagation areas (as a reflection of the situation on the European and world markets) and the support for this branch (though for a short time) from subsidies (allowances for produced and certified seeds). The area occupied by grasses grown for seed decreased from nearly 15 000 ha in the year 2001 to 10 319 ha in 2003. Positive technological changes include application of better harvesting technology. However, the system of post-harvest seed processing did not improve, but worsened instead. An important feature was a low level of inputs, predominantly fertilisers and pesticides. As for average yields/hectare, there was neither a marked decrease nor increase. The spectrum of cultivated species can be regarded as stable; it was traditionally very broad – about twenty (Figures 1–4). Climatic conditions in the years 1995–2004 were variable. We tried to answer the question of what effect the changing factors had on the occurrence and spectra of weeds, diseases and pests that are important factors controlling yield and quality of grass seeds.

MATERIAL AND METHODS

Data about the occurrence of important weeds, diseases and pests in the years 1995–2004 in seed stands come from the reports presented by the Cen-

Partly supported by the Ministry of Agriculture of the Czech Republic, Project No. QD 1055.

tral Institute for Supervising and Testing (ÚKZÚZ) in registration proceedings. The occurrence of weeds, diseases and pests in the natural seed is based on the results from laboratories at seed growing companies, on preliminary analyses of seeds supplied to seed cleaning stations before cleaning. Monitoring of harmful agents of biotic origin during the vegetative period was done in individual years on an area of 2000–4500 ha and included 19 grass species. The results of seed analyses were obtained in individual years from the analyses of 2200–4500 t of natural seed of 19 grass species. What was monitored was occurrence, not intensity.

Data about the occurrence of ergot sclerotia were taken from the long-term monitoring of this parasite in Northern Moravia, an important growing region of the Czech Republic.

Meteorological data originated from the Meteorological Station at Mořkov.

RESULTS

Seed stands – weeds

Monocotyledonous and dicotyledonous weed species, which were found on more than 1% of fields under study, are presented in Table 1. The

Table 1. Occurrence (%) of important weeds in seed stands of grasses during vegetation in the Czech Republic, 1995–2004

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Average
Elytrigia repens	43.4	77.2	82.8	76.5	79.4	78.6	65.1	64.2	67.3	66.2	70.1
Cultivated grasses	23.5	43.2	61.3	55.8	53.6	57.8	56.5	60.0	63.8	44.7	52.0
Rumex spp.	12.5	50.1	57.9	42.6	38.2	36.8	60.4	78.0	43.4	31.6	45.2
Matricaria recutita, Tripleurospermum inodorum	20.6	49.7	32.0	38.9	41.8	43.6	29.6	26.6	32.9	30.0	34.6
Cirsium arvense	2.6	45.4	23.9	31.2	35.3	36.4	40.2	30.6	39.7	0.0	28.5
Apera spica-venti	40.4	38.2	28.4	32.6	34.5	33.6	16.9	15.7	23.8	17.9	28.2
Poa spp. (non-cultivated species)	48.6	14.7	26.6	34.4	36.0	35.8	15.1	23.4	25.2	21.6	28.1
Galium spp.	29.1	16.9	14.3	15.8	16.2	14.8	18.3	15.2	5.5	8.8	15.5
Cereals	41.2	11.1	13.0	13.6	21.8	19.6	5.8	2.8	10.2	12.6	15.2
Viola tricolor	11.1	10.4	6.4	9.6	12.6	13.4	10.1	3.9	6.7	9.3	9.3
Avena fatua	1.8	13.7	9.1	8.2	11.3	11.2	0.7	5.9	10.6	11.2	8.4
Myosotis arvensis	18.2	6.5	4.6	6.2	5.8	4.3	11.9	6.0	1.4	4.2	6.9
Galeopsis spp.	1.5	3.4	1.5	2.9	2.2	2.1	1.3	27.5	1.1	4.1	4.8
Polygonum spp.	3.4	6.4	4.7	5.3	4.6	4.3	0.7	3.8	7.0	3.8	4.4
Chenopodium spp.	3.8	6.5	2.8	3.3	3.2	4.3	0.9	2.4	9.4	5.4	4.2
Echinochloa crus-galli	1.4	3.9	2.5	3.8	5.6	5.8	0.0	0.1	3.7	4.2	3.1
Lapsana communis	11.2	3.7	0.0	4.6	5.8	4.8	0.0	0.2	0.0	0.4	3.1
Thlaspi arvense	3.3	4.0	0.0	3.9	3.4	3.2	1.3	2.1	0.0	1.1	2.2
Brassica napus	0.0	1.8	1.0	2.2	3.8	4.3	0.6	1.5	1.9	1.5	1.9
Holcus sp.	0.0	0.0	0.0	0.0	0.0	0.0	2.8	3.0	4.0	3.0	1.3
Leucanthemum vulgare	0.0	2.9	0.0	3.2	3.2	1.7	0.0	0.0	0.0	0.0	1.1
Raphanus raphanistrum, Sinapis arvensis	1.1	1.5	0.0	1.6	0.6	1.2	0.0	0.5	0.5	0.0	0.7
Veronica sp.	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.2	1.9	1.7	0.6

% – percentage of fields in which the weed was recorded

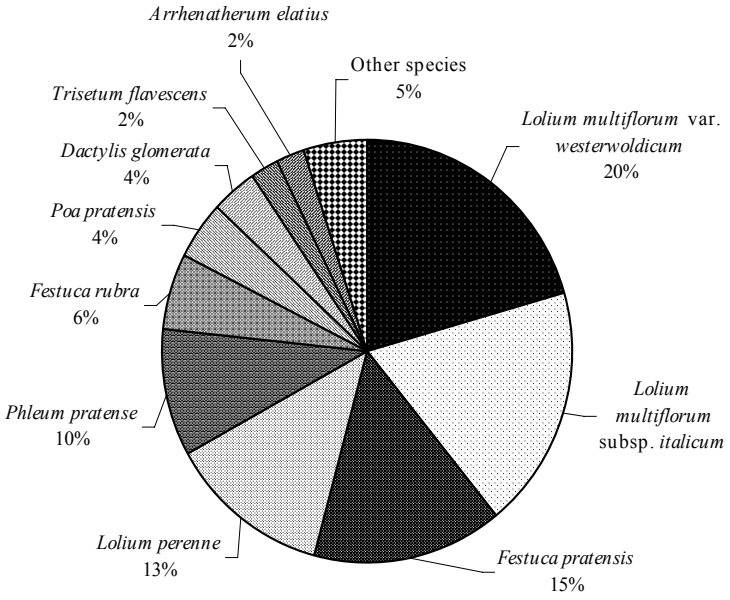

Figure 1. Acreage of grasses grown for seed in the Czech Republic in 1995

table shows that the most serious weed species found by ÚKZÚZ inspectors on more than 25% of the infected fields were predominantly *Elytrigia repens* (L.) Nevski, followed by non-cultivated grasses, species of the genera *Rumex, Matricaria* and *Anthemis, Apera spica-venti* (L.) P. B., *Cirsium arvense* (L.) Scop. and different species of the genus *Poa.*

Seed stands – diseases

The most abundant diseases were parasitic silver top of grasses (found on more than 38% of visited fields), followed by powdery mildew (*Blumeria graminis* /DC./ Speer 1975) and graminicolous rusts occurring on more than 17% of the fields under study (Table 2).

Seed stands – pests

Almost regular damage was caused by *Muridae* rodents, the occurrence of other animal pests was very low (Table 3).

Natural seed – weeds

Among the most important weeds whose seeds were found in more than 25% of samples in the years 1994–2002 are quackgrass (*Elytrigia repens*), non-cultivated grasses, camomile (*Matricari*a spp.), barnyard grass (*Apera spica-venti*), various cereal crops, meadow grass (*Poa trivialis* L.) and species of the genus *Rumex*. Important weeds from the aspect of seed production were also *Myosotis* sp.div. and *Chenopodium* sp.div. An overview of

Table 2. Occurrence (%) of important diseases in seed stands of grasses during vegetation in the Czech Republic, 1995–2004

Disease	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Average
Silver top	48.1	42.5	41.1	13.8	44.2	32.3	40.4	35.8	36.3	18.8	35.3
Blumeria graminis	40.0	23.8	18.9	27.8	36.8	15.5	9.9	10.0	24.3	4.2	21.1
Graminicolous rusts	22.0	12.7	14.7	17.3	22.6	24.5	14.4	33.4	4.0	8.3	17.4
Leaf spots	13.7	9.6	7.5	12.8	14.6	11.4	17.4	15.7	29.2	15.0	14.7
Epichloe typhina	0.6	0.1	0.1	0.2	0.3	1.5	1.7	2.3	0.9	0.2	0.8
Claviceps purpurea	0.0	0.0	1.5	2.2	2.3	0.0	0.0	0.0	0.0	0.0	0.6
Septoria spp.	0.6	0.7	0.0	0.9	1.2	0.0	0.0	0.0	0.2	0.1	0.4
Ustilago perennans	1.3	0.2	0.2	0.3	0.3	0.0	0.75	0.5	0.0	0.0	0.4

% – percentage of fields in which the disease was observed

Table 3. Occurrence (%) of important pests in seed stands of grasses during vegetation in the Czech Republic, 1995–2004

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Average
Mice	6.3	0.0	4.3	7.6	8.7	2.5	4.9	3.0	0.0	1.1	3.8
Amaurosoma flavipes	0.0	0.8	1.5	0.8	0.7	4.5	0.0	0.6	0.3	1.0	1.2
Thrips	0.0	0.0	0.0	0.0	0.0	3.6	4.3	0.9	2.0	1.0	1.2
Aphids	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.2	0.0	0.0	0.1

% – percentage of fields in which the pest was observed

weeds whose seeds were present in more than 3% of grass samples is given in Table 4.

Natural seed – diseases

A typical "seed-related" disease is ergot (*Claviceps purpurea* /Fr./ Tul.). The occurrence of its sclerotia in the seeds of 11 grass species in a northern Moravian growing region has been studied since 1979 (Cagaš & Macháč 2001). In the years 1995–2004 ergot occurred in the range of 0.1% to 1.6% in six grass species – in both forms of *Lolium multiflorum* Lamk., *Lolium* × *hybridum* (Hausskn.), *Lolium perenne* L., *Festuca rubra* L. and *Poa pratensis* L. (Table 5).

DISCUSSION

In the present system of growing grasses for seed, i.e. narrow rows without inter-row cultivation and with direct harvesting only, weeds are one of the major limiting factors of yield and its quality. Therefore, long-term monitoring of weed occurrence and proportions in individual grass species is of great importance: it may reveal shortcomings in the technology of cultivation, show the spread of new or reappeared weed species, and it may also positively influence technological research, including the development of herbicide preparations specifically for grass seed cultivation or, possibly, treatment of grass sod in general.

The tables summarising the spectra of weeds at the time of vegetation and in seed samples revealed several important facts. One of them is a high occurrence of quackgrass both in stands and in seed samples. A probable explanation for this, but not an excuse for the bad situation, may be a high proportion of temporary ryegrasses (annual ryegrass and Italian ryegrass) in the species spectrum – in the stands heavily infested with weeds, only the second cutting was harvested for seed. However, a very high proportion of quackgrass

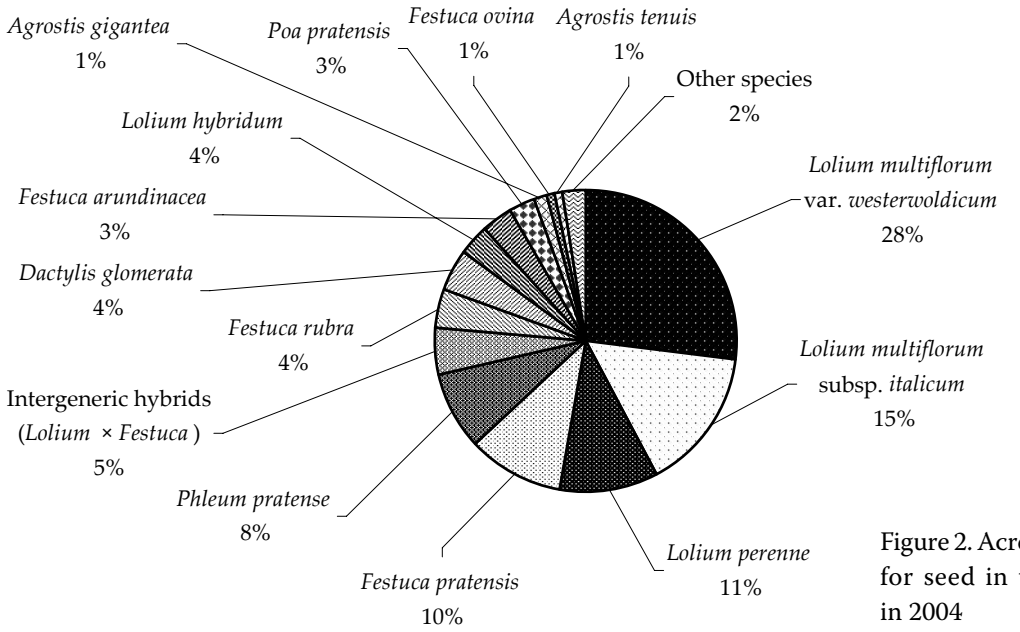

Figure 2. Acreage of grasses grown for seed in the Czech Republic in 2004

Table 4. Occurrence (%) of seeds of important weeds in samples of natural grass seeds in the Czech Republic, 1995–2004

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Average
Elytrigia repens	43.4	34.3	33.7	35.6	38.4	33.8	77.3	67.5	54.4	65.2	48.41
Matricaria spp.	18.1	34.0	23.8	22.1	28.2	48.0	61.9	45.2	42.7	21.2	34.5
Non-cultivated grasses	21.9	21.7	26.7	26.4	24.6	70.2	51.1	37.3	37.3	12.9	33.0
Apera spica-venti	40.4	43.6	20.9	27.6	31.8	37.3	34.7	31.1	16.7	20.5	30.5
Poa trivialis	32.7	28.2	31.7	32.7	33.1	30.5	28.3	35.3	25.7	20.3	29.8
Cereals	36.0	33.2	25.0	29.2	29.3	44.4	33.7	37.3	12.6	8.3	28.9
Rumex spp.	12.5	10.1	25.0	13.8	14.5	45.1	63.7	52.5	22.5	18.2	27.8
Chenopodium spp.	12.5	10.1	25.0	13.8	14.5	45.1	63.7	52.5	23.2	7.5	18.5
Galium spp.	29.1	17.0	13.3	12.6	14.8	13.6	38.3	26.3	5.2	14.0	18.4
Myosotis spp.	18.2	14.4	9.6	12.4	13.2	17.1	44.0	34.7	2.0	8.1	17.4
Poa annua	15.9	6.1	12.5	13.6	14.9	18.8	21.2	0.0	8.6	12.4	12.4
Viola tricolor	11.1	7.0	9.0	11.3	10.9	6.9	21.2	13.1	6.0	21.8	11.8
Polygonum spp.	3.4	16.8	10.3	11.4	10.9	5.2	11.8	15.9	7.7	0.0	9.3
Thlaspi arvense	3.3	15.3	9.7	8.2	7.6	9.6	9.8	16.9	6.9	0.0	8.7
Vicia spp.	16.3	12.9	9.3	8.2	8.8	3.3	5.1	3.2	3.0	1.7	7.2
Papaver rhoeas	3.0	2.9	7.7	6.8	7.2	15.1	7.0	5.7	9.3	4.0	6.9
Brassica napus	0.0	0.8	0.0	0.0	1.9	17.5	31.1	9.6	6.2	1.3	6.8
Lapsana communis	11.2	8.4	5.0	8.3	7.6	10.9	0.8	5.6	3.0	2.4	6.3
Veronica spp.	0.0	0.0	0.0	0.0	0.0	9.6	21.5	13.4	8.7	5.8	5.9
Echinochloa crus-galli	4.6	4.8	5.3	5.5	6.9	3.7	1.0	7.1	18.8	1.3	5.9
Trifolium spp.	3.0	2.9	7.7	6.8	7.2	15.1	7.0	5.7	4.1	1.8	5.5
Avena fatua	1.8	4.4	5.9	6.2	7.8	5.1	4.1	7.7	2.5	3.6	4.9
Cirsium arvense	2.6	1.7	0.0	2.5	2.4	3.8	10.5	8.3	7.7	7.7	4.0
Galeopsis spp.	1.5	1.7	0.0	2.3	2.6	4.5	5.4	8.8	2.0	7.0	3.6
Bromus spp.	4.1	2.4	0.0	3.8	3.4	4.1	8.7	2.5	0.7	0.0	3.3
Carum carvi	2.1	2.3	0.0	2.2	0.8	6.0	0.5	0.9	3.7	3.8	2.2
Holcus spp.	0.0	0.0	0.0	0.0	0.0	9.6	2.3	5.2	1.3	0.0	1.8
Stellaria media	2.7	0.0	3.0	3.8	4.2	0.0	0.0	0.0	0.0	4.1	1.8
Melandryum album	0.0	0.0	0.0	0.0	0.0	0.0	8.1	6.0	0.0	0.0	1.4
Fagopyrum spp.	0.0	0.0	0.0	0.0	0.0	0.0	6.5	6.5	0.0	0.0	1.3
Alopecurus geniculatus	0.1	0.2	0.0	0.2	0.2	0.0	0.0	9.0	0.0	0.0	1.1
Spergula spp.	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0	1.1

% – percentage of samples in which the weed was recorded

in seed samples suggested that this principle was not strictly applied and that this species invaded all grass species. Long-term monitoring indicated increased infestation with the species, which was indicative of mistakes in technology rather than of the impact of external factors. A similar increase in distribution was seen in *Cirsium arvense* (during vegetation), and in species of the genera *Matri-*

Table 5. Occurrence of ergot sclerotia (highest % determined) in grass seeds in Northern Moravia, 1995–2003

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003
Phleum pratense					–	–	–	–	–
Lolium hybridum				1.1	–	1.4	0.3	–	–
Lolium multiflorum var. *westerwoldicum*		0.1	0.3	0.4	0.3	0.8	0.6	0.5	1.6
Lolium multiflorum subsp. *italicum*	0.1					0.9			
Lolium perenne			0.3		0.2			0.1	
Festuca rubra		0.7	0.6		0.3		0.5	0.1	
Festuca pratensis	0.1								
Poa pratensis	2.5	0.8	0.3		0.4	2.1	–	1.1	0.4
Cynosurus cristatus									
Dactylis glomerata									
Trisetum flavescens									

Occurrence of ergot sclerotia was not evaluated in 2004

caria, *Anthemis* and *Rumex* (in seed samples). In all these cases the increased occurrence of the species indicated technological weaknesses. Effective preparations based on clopyralid, fluroxypyr, MCPA and others are available (Macháč *et al.* 2001).

A long-term problem of grass seed cultures are weeds of the family *Poaceae,* i.e. the non-cultivated grasses *Poa annua* and *P. trivialis*, of *Apera spica-venti* and volunteer plants of cereals whose elimination from grasses grown for seed is still a serious problem.

Enormous problems arise from establishing grass seed cultures without a cover crop in the spring, especially in species that develop slowly when the invasion of *Echinochloa crus-galli* (L.) P. B. is able to weaken young stands. Among the factors contributing to the development of this weedy grass species are, undoubtedly, high temperatures during spring in the last years (Figure 5).

The most serious disease of grass seed production in the Czech Republic is, undoubtedly, parasitic silver top (white head) caused by the fungus *Fusarium poae* (Peck.) Wollenw., and transmitted by the bug *Leptopterna dolobrata* (Linnaeus, 1758). As is evident from the long-term observations, the incidence of this disease fluctuates but its harmfulness is manifested by record occurrences

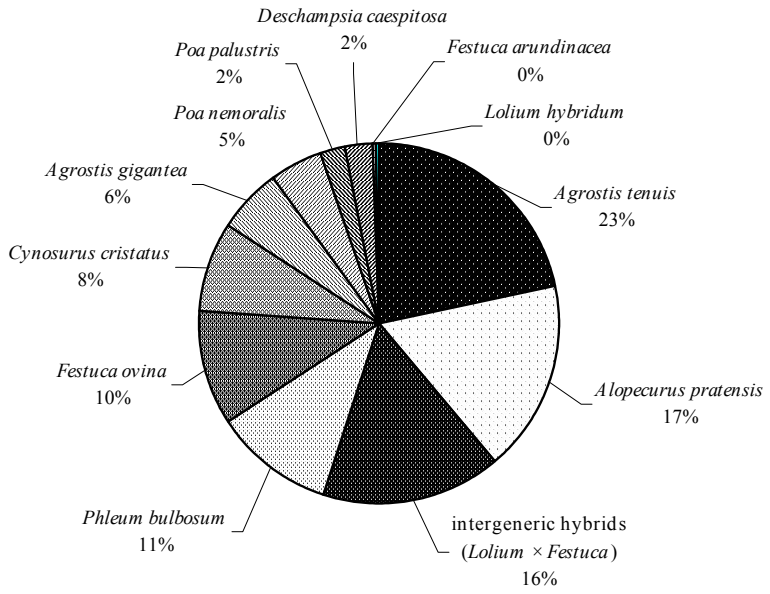

Figure 3. Acreage of grasses grown for seed (other species) in the Czech Republic in 1995

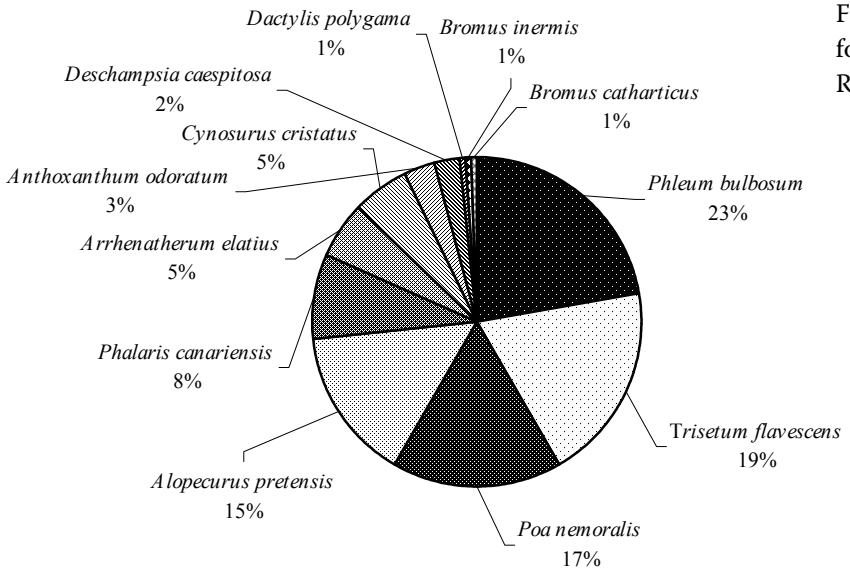

Figure 4. Acreage of grasses grown for seed (other species) in the Czech Republic in 2004

in some years (1995,1999) and by a high average level (Table 2). These fluctuations and differences between individual years may be caused both by species proportions and stand age. The fact that silver top was, on average, recorded on almost 40% of the areas visited suggests not only regular incidence and harmfulness of this disease but also negligence on the part of growers. They are well informed about potential chemical and non-chemical control.

Graminicolous rusts are an interesting phenomenon in grass seed production in Central Europe. Their occurrence is regular and relatively frequent (Table 2), but with very few exceptions it has no significant impact on quantity and quality of seed production. The rusts include predominantly the following species: *Puccinia coronata* Corda var. *coronata*, *P. graminis* subsp. *graminicola* Urban, *P. poarum* Nielsen 1877 and *P. poae-nemoralis* Otth. The years 1999 and 2000 witnessed a widespread occurrence of *P. graminis* subsp. *graminicola* on seed stands of some varieties of perennial ryegrass, which was unprecedented till that time. An important factor which contributed to this state

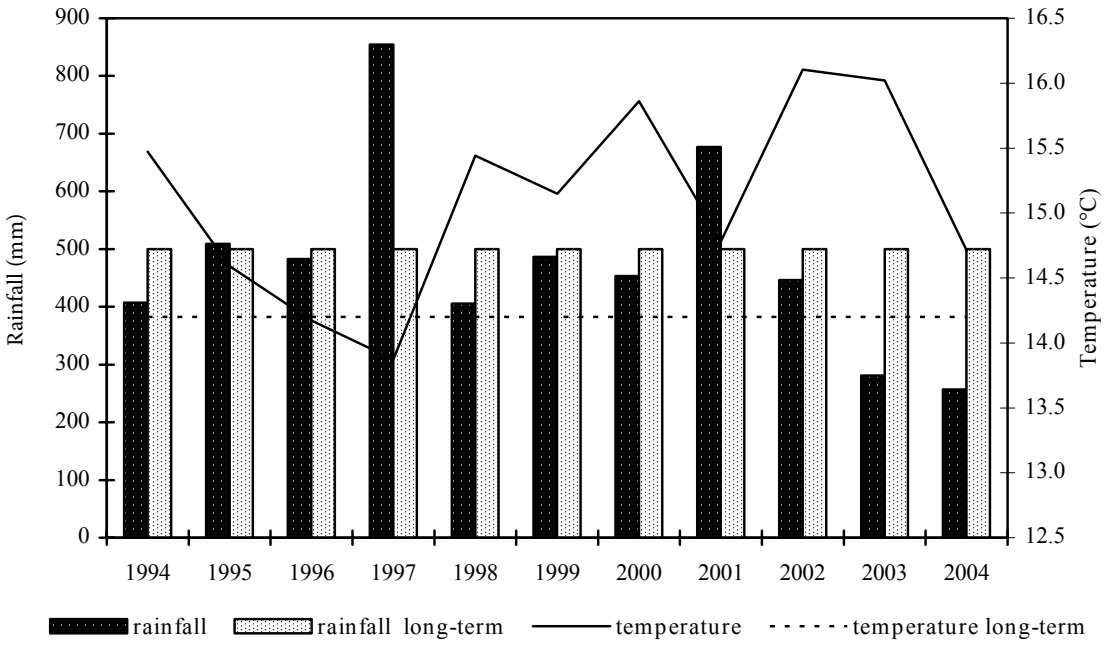

Figure 5. Rainfall and mean temperatures during the vegetative periods 1995–2004

Table 6. Changes in area and grass seed production in the Czech Republic in the years 1995–2004

Harvest year	Area (ha)	Production (t)
1995	8 927	4 859
1996	9 431	4 632
1997	13 800	6 382
1998	15 639	7 253
1999	13 623	7 086
2000	14 660	5 271
2001	14 892	4 821
2002	11 557	3 860
2003	10 319	5 055
2004	14 002	9 025

were high mean temperatures in April and May of the years 1998–2000; especially April extremes, compared with other years.

A quite high occurrence was recorded with *Blumeria graminis* whose economic harmfulness in grass seed cultures has not been precisely determined. As for mildew and rusts, no chemical control is usually applied; but the high infection with black stem rust during 1999 and 2000 caused increased interest in chemical control, both preventive and curative. The same applies to leaf spots.

The observations on grass seed cultures which are not included in the tables suggest a higher occurrence of different *Fusarium* and virus diseases. For example, most varieties of the species *Lolium multiflorum* var. *westerwoldicum* and subsp. *italicum* are infected by ryegrass mosaic virus (RGMV) whose economic harmfulness is high, especially in less tolerant varieties (Pokorný & Cagaš 2003). According to Cagaš and Pokorný (2004), RGMV causes reduction in height of fertile tillers, delay in heading and markedly lower seed yields in annual ryegrass (diploid and tetraploid varieties). However, no negative effect on germination capacity and 1000-seed weight was found.

A typical feature and an integral part of grass seed production is ergot whose sclerotia reduce both quantity and quality of seed yield. Their number is dependent on many factors ranging from climatic conditions to harvesting technology and resistance of the variety (Cagaš & Macháč 2002). Major hosts under Czech conditions are species of the genus *Lolium* and *Poa pratensis*. Though the rate of occurrence fluctuates from year to year, the range of the most important hosts is stable from a long-term viewpoint; major host species are Italian ryegrass and Kentucky bluegrass (Table 5).

The analysis of the long-term study of the weed flora accompanying grass seed populations in the Czech Republic shows stability of its spectrum and only little influence of external effects of anthropogenic or climatic origin. The same applies to the spectrum of pests. The spectrum of important diseases was stable in the years 1994–2003; only the level of infection and harmfulness of rusts was most likely affected by climatic factors.

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Received for publication March 27, 2006
Accepted after corrections July 7, 2066

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