The effect of different soil core samplers on precision of estimating weed seedbank in soil

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ABSTRACT

The effect of different soil sampling procedures on the precision of estimating the weed seedbank in soil using three soil core samplers with a circular base of 1.3, 6.4 and 8.0 cm in diameter was studied in a model experiment. The results showed the importance of a methodological approach. The soil sampler with a larger diameter is more useful for the objective assessment of the species spectrum (detection of seeds of all weed species in the soil). Furthermore, the value of the coefficient of variation (v_x) decreases along with the increasing diameter of the soil sampler. The value of v_x assessed in partial samples taken with a sampler of 1.3 cm diameter was double to three times higher than for soil samplers of 6.4 and 8.0 cm. The value of v_x increased in individual weed species at decreasing seed frequency in individual partial samples from 17.82 to 316.23%. The soil core with the diameter of 8.0 cm on the area of 1 m^2 is optimal for the exact research. To estimate the weed seedbank in soil in small-plot experiments, one partial sample on the area of 5 m^2 is recommended. To obtain comparable results, it is necessary to take a higher number of samples at a decreasing diameter of the soil sampler. Likewise, a larger amount of samples is needed to detect less abundant species.

Keywords: weed seedbank in soil; soil sampling; precision of estimating

The estimation of the weed seedbank in topsoil is rather labour- and time-consuming. Some questions concerning soil sampling, particularly the determination of their numbers, size and sampling procedures – use of different types of soil samplers, sampling depth, etc., have not been defined until now (Dvořák 1971, Thompson a Grime 1979, Rahman et al. 1995). On the one hand, there are references to investigations based on sampling and analyses of partial samples, and on the other hand, those based on the analysis of an average sample.

The number of soil samples and their size affect the precision of obtained data on the weed seedbank in soil. However, along with increasing precision, the estimation becomes more time-consuming and decreases the labour productivity. In order to achieve an adequate precision of estimation, it is necessary to determine the optimum number of samples taken per unit area and/or the volume of the analyzed soil (Barralis et al. 1986, Benoit et al. 1989, Dessaint et al. 1990). The number of replications (cores) does not depend on the size of the examined area, but on the uniformity of its weed infestation (Dvořák 1971).

Various types of soil core samplers are used to take soil samples. They differ by the shape, diameter (the area of the circular base), and the volume of taken soil. In order to obtain reliable results, when partial samples are taken and analyzed, their volume should be identical. The diameter of soil samplers used by various authors varies from 1.9 to 10.0 cm, whereas most authors report the diameter of 3.5 to 5.0 cm. The volume of samples is between 14 and 1 020 cm^3, however most often from 100 to 200 cm^3.

The model experiment directed to studying the effect of different soil sampling procedures on the precision of estimation of the weed seedbank in soil was conducted in 1999. Its objective was to obtain bases for increasing precision and unification of methodological approaches.

MATERIAL AND METHODS

Soil sampling

The soil samples were taken in spring 1999 (April 21–23) in three fields (designated 1, 2 and 3) at the location Žabčice (179 m above sea level, 49°01'N, 16°37'E) situated 25 km south of Brno. It is a warm and dry region with annual average temperature of 9.1°C and annual precipitation of 518 mm. The samples were always taken after soil preparation before crop sowing and planting.

The plot of 25 m^2 (5 × 5 m) was marked out at each of these fields. Three soil core samplers with the circular base of different diameter were used:

– agrochemical soil sampler with a diameter of 1.3 cm – used to take samples for nutrient analyses,
– Kalentějev soil sampler with a diameter of 6.4 cm – it is a hollow cylinder with sharpened lower boundary,

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– soil sampler of the Ejkelkamp firm with a diameter of 8.0 cm.

The volumes of the taken soil were 39.8, 964.6 and 1 507.0 cm^3 at the depth of 30 cm. Ten partial samples, uniformly distributed across the concerned plot, were collected using each soil sampler.

Analysis of soil samples

The methodology according to Dvořák and Krejčíř (1974) was used to estimate numbers of weed seeds in individual soil cores.

The soil is placed into a beaker and water is added to about 1 cm over the soil and kept for 24 hours. After this time, the material is poured into a shaking bottle that is shaken in a horizontal autoclave for 30 min in order to disaggregate the soil.

Then the content of the shaker is elutriated on a metal sieve with 0.25 mm openings with a mild flow of running water (a rubber hose connected to the tap) until all particles smaller than 0.25 mm are washed away (washings are completely clear).

The residue on the sieve (the non-elutriated proportion of mineral and organic particles larger than 0.25 mm and weed seeds) is rinsed into a beaker and filtered. This part that remains on the filter paper is dried at the room temperature and weed seeds are collected using tweezers and a preparation needle, identified and counted. Due to small dimensions of seeds, it is necessary to use a magnifying lens or stereoscopic microscope (5–10×).

Conversion of the weed seed number to the area and statistical assessment of results

The numbers of seeds determined in partial samples were converted to the area of 1 m^2 using the coefficient K (Hron and Kohout 1967):

$$K = 10\,000/p$$

where: p = area of the sampler base (soil core) in cm^2

The numbers of all seeds in total and those of individual species in samples taken by three different soil samplers were compared.

The coefficient of variation (v_x) was used to assess the variation in obtained results. In addition, the theoretical minimum number of collected samples (n) was calculated for the total number of weed seeds and for individual species. Based on the results obtained from the pre-selection of 10 partial samples, the extent of the selection set was determined for each of the three soil samplers used. The extent of the selection set was determined for three levels of acceptable error. The acceptable error for each species was chosen as 5 (designated Δ_5), 10 (Δ_{10}) and 20% (Δ_{20}) respectively of the average seed number that was found in the pre-selection. The following equation was used for the calculation:

$$n = t^2_{1-\alpha/2} . s_x^2/\Delta^2$$

where: $t_{1-\alpha/2}$ – fractile of Student's t-distribution
s_x^2 – variance
Δ – acceptable error

In the total number of all seeds and the total number of individual species, homogeneity of variances of input data was determined by Cochran's test. That justified using the analysis of variance and the Tukey-test for subsequent testing of significance of medium value differences. In the total number of all seeds of individual species, the required homogeneity of variances was absent, therefore the analysis of variance could not be used. Instead the Kruskal-Wallis test was used, which is a non-parametric analogy to the analysis of variances, completed with the Tukey-test for the determination of significance of medium value differences.

RESULTS

Effect of soil sampling procedure

A highly significant effect of the soil sampling procedure on the average number of species in the sample was found by comparison of results obtained (Table 1). The

Table 1. Results of analysis of variance for the total number of all seeds and the average number of species per sample

Sources of variation	Degree of freedom (n)	Mean square (MS)	
		total number of all seeds	total number of species per sample
A-field	2	8 295 877 123**	105.100**
B-sampling procedure	2	582 805 320	746.133**
A-field × B-sampling procedure	4	41 904 109	6.883
Error	81	604 954 541	7.236
Total	89	751 980 889	26.024

** highly significant ($P \leq 0.01$)

Table 2. Differences among sampling procedures (Tukey-test, $P \leq 0.01$)

Sampling procedure	Total number of all seeds (pc/m^2)	Average number of species per sample (pc)
Soil sampler – 1.3 cm	71 090[a]	5.4[a]
Soil sampler – 6.4 cm	78 472[a]	13.5[b]
Soil sampler – 8.0 cm	78 953[a]	14.4[b]
LSD_T	18 636	2.04

Different letters (a, b) indicate significant differences at $P \leq 0.01$

Table 3. Comparison of species frequencies in partial samples (a total of 10) taken with different soil samplers

Field	Soil sampler (diameter)	Number of species with regular (100%) occurrence	Number of species occurring in 50% and more cores
Field 1	1.3 cm	1	3
	6.4 cm	2	13
	8.0 cm	4	15
Field 2	1.3 cm	1	4
	6.4 cm	6	18
	8.0 cm	6	17
Field 3	1.3 cm	0	6
	6.4 cm	3	16
	8.0 cm	5	17

difference in the total number of all seeds when using different soil samplers was not statistically significant.

Table 2 shows that the very significantly lower number of weed species (on average 5.4 species per sample) was found in the samples taken with the soil sampler at the diameter of 1.3 cm in comparison with the soil samplers of 6.4 cm (13.5 species per sample) and 8.0 cm (14.4 species per sample). No significant difference was found in the total number of all seeds among various sampling procedures (a different diameter of the sampler). In spite of that, the apparently lowest number was found in samples taken with the soil sampler of 1.3 cm (71 090 pc/m^2, pc = piece). The seed numbers taken with the soil samplers of 6.4 cm and 8.0 cm diameters were almost identical, i.e. 78 953 and 78 472 pc/m^2.

In all three fields, the lowest numbers were found for regularly occurring weeds (i.e. 100% = the species is present in all of 10 taken samples) in the samples taken with the soil sampler of the smallest diameter. In the field 1 the 100% occurrence was found in *Chenopodium album* only when the soil sampler of 1.3 cm diameter was used. By contrast, the 100% occurrence was also determined in *Amaranthus retroflexus* (beside *Chenopodium album*) when samples were taken with the soil sampler of 6.4 cm diameter. When the soil sampler of 8.0 cm diameter was used, the 100% occurrence was found in four species: *Chenopodium album*, *Amaranthus retroflexus*, *Thlaspi arvense* and *Sinapis arvensis*. The number of species with regular occurrence increased (or it was exceptionally identical) along with the diameter of the soil sampler in the other fields, too. The same trends are apparent when numbers of species present in 50% and more cores by the soil samplers with different base diameters were compared (Table 3). The numbers were: 3–6 species at the 1.3 cm diameter, 13–18 species at 6.4 cm and 15–17 species at 8.0 cm.

The seeds of three weed species whose numbers significantly differed among soil sampler types were always present in all three fields. The seeds of *Silene noctiflora*, *Polygonum lapathifolium* and *Veronica persica* were present in the field 1; *Sinapis arvensis*, *Papaver rhoeas* and *Polygonum lapathifolium* in the field 2; *Lamium purpureum*, *Amaranthus retroflexus* and *Fallopia convolvulus* in the field 3.

Table 4 shows that seeds of more weed species were found when the soil samples were taken with the samplers of a large diameter (6.4 and 8.0 cm). No seeds of a great number of species were found in the single sample taken with the soil sampler of 1.3 cm diameter, while they occurred when two other samplers of a larger diameter were used. For example, in the field 1 these were *Consolida regalis*, *Cirsium arvense*, *Euphorbia helioscopia*, *Stellaria media*, *Polygonum lapathifolium* and *Veronica persica*; in the field 2 – *Anagallis arvensis*, *Tripleurospermum inodorum*, *Atriplex patula*, *Solanum nigrum*, *Elytrigia repens* and *Polygonum aviculare*; in the field 3 – *Anagallis arvensis*, *Capsella bursa-pastoris*, *Chenopodium hybridum*, *Stellaria media* and *Elytrigia repens*.

Seeds of some species were found using one of the soil samplers only. When the soil sampler of 1.3 cm diameter was used, the seeds of *Viola arvensis* were found in the field 2 and *Tripleurospermum inodorum* in the field 3. *Atriplex patula* and *Viola arvensis* were detected with the soil sampler of 6.4 cm diameter in the field 1 and *Descurainia sophia* in the field 3. Using the soil sampler of 8.0 cm diameter, *Anagallis arvensis* and *Tripleurospermum inodorum* were found in the field 1, and *Euphorbia helioscopia* in the fields 2 and 3.

Numbers of weed seeds in individual fields

The comparison of obtained results given in Table 5 shows highly significant differences among fields in the total number of all seeds and the average number of species per sample.

As data in Table 5 indicate, the lowest number of all seeds was determined in the field 1 (57 704 pc/m^2). In comparison with the field 3 (80 852 pc/m^2) and the field 2 (89 959 pc/m^2), highly significant differences ($P \leq 0.01$) were 23 148 and 32 255 pc/m^2. The difference of 9 107 pc/m^2 between the fields 2 and 3 was not statistically significant.

The average number of species per sample very significantly differed in the field 1 (8.9 species) vs. the field 3 (12.4 species). The insignificant difference was found

Table 4. Weed species detected in samples taken with different soil samplers

Species	Field 1			Field 2			Field 3		
	diameter of soil sampler								
	1.3 cm	6.4 cm	8.0 cm	1.3 cm	6.4 cm	8.0 cm	1.3 cm	6.4 cm	8.0 cm
Amaranthus retroflexux	×	×	×	×	×	×	×	×	×
Anagallis arvensis	–	–	×	–	×	×	–	×	×
Atriplex patula	–	×	–	–	×	×	×	×	×
Capsella bursa-pastoris	×	×	×	–	–	–	–	×	×
Cirsium arvense	–	×	×	×	×	×	×	×	×
Consolida orientalis	–	–	–	×	×	×	×	×	×
Consolida regalis	–	×	×	–	–	–	–	–	–
Convolvulus arvensis	×	×	×	×	×	×	×	×	×
Descurainia sophia	–	–	–	–	–	–	–	×	–
Echinochloa crus-galli	×	×	×	×	×	×	×	×	×
Elytrigia repens	–	–	–	–	×	×	–	×	×
Euphorbia helioscopia	–	×	×	–	–	×	–	–	×
Fallopia convolvulus	×	×	×	×	×	×	×	×	×
Galium aparine	×	×	×	×	×	×	×	×	×
Hyoscyamus niger	–	–	–	×	×	×	×	×	×
Chenopodium album	×	×	×	×	×	×	×	×	×
Chenopodium hybridum	–	–	–	×	×	×	–	×	×
Lamium purpureum	×	×	×	×	×	×	×	×	×
Papaver rhoeas	×	×	×	–	×	×	×	×	×
Polygonum aviculare	–	–	–	–	×	×	–	×	–
Polygonum lapathifolium	–	×	×	×	×	×	×	×	×
Silene noctiflora	×	×	×	×	×	×	×	×	×
Sinapis arvensis	×	×	×	×	×	×	×	×	×
Solanum nigrum	–	–	–	–	×	×	×	×	×
Stellaria media	–	×	×	×	×	×	–	×	×
Thlaspi arvense	×	×	×	×	×	×	×	×	×
Tripleurospermum inodorum	–	–	×	–	×	×	×	–	–
Veronica persica	–	×	×	×	×	×	×	×	×
Viola arvensis	–	×	–	×	–	–	×	×	×
Total number of species	12	20	20	18	24	25	20	26	25

– the species was absent, × the species was present

between the field 2 (11.8 species) and 3 (12.4 species), and between the fields 2 and 1 (8.9 species, Table 5). The data were calculated from the average of values obtained by soil sampling with individual soil samplers.

In all three fields and using all three sampling procedures (soil samplers of the diameters 1.3, 6.4 and 8.0 cm respectively), the seeds of 10 weed species were found: *Lamium purpureum*, *Sinapis arvensis*, *Echinochloa crus-galli*, *Silene noctiflora*, *Amaranthus retroflexus*, *Chenopodium album*, *Thlaspi arvense*, *Fallopia convolvulus*, *Galium aparine* and *Convolvulus arvensis*.

Assessment of variation in results obtained

The coefficient of variation (v_x) was the lowest in the total number of all seeds and the number of species per sample. Table 6 indicates that there is an apparent decreasing tendency of v_x along with the increasing diameter of the soil sampler used. The coefficient v_x increased in individual weed species along with the decreasing frequency of seeds in individual samples in the range from 17.82% (for *Amaranthus retroflexus* in the field 2, soil sampler of 6.4 cm diameter) to 316.23% (for *Papaver rhoeas* in the field 1, soil sampler of 1.3 cm diameter). Therefore, v_x is higher for the species of irregular up to sporadic occurrence than those that occur regularly. The value of v_x calculated for the total number of all seeds and the number of species per sample was low. The values of v_x were also low in *Chenopodium album* and *Amaranthus retroflexus* in the field 1, in *Sinapis arvensis*, *Amaranthus retroflexus*, *Chenopodium album*, *Polygonum lapathifolium* and *Galium aparine* in the field 2, and in *Echinochloa crus-galli* and *Amaranthus retroflexus* in the field 3.

Table 5. Differences among fields (Tukey-test, $P \leq 0.01$)

Field	Total number of all seeds (pc/m^2)	Total number of species per sample (pc)
Field 1	57 704^a	8.9^a
Field 2	89 959^b	11.8^{ab}
Field 3	80 852^b	12.4^b
LSD_T	18 636	2.04

Different letters (a, b) indicate significant differences at $P \leq 0.01$

Calculation of the theoretical minimum number of taken samples

The calculated theoretical minimum number of taken samples for the estimation of the weed seedbank in soil at the given acceptable error depends on the diameter of the soil sampler and the coefficient of variation for the total number of all seeds. Table 7 shows that 30 samples taken with the soil sampler of 1.3 cm diameter, 8 samples with the soil sampler of 6.4 cm diameter and 5 samples with the soil sampler of 8.0 cm would be necessary at Δ_{20} (the acceptable error determined as 20% of the average number of seeds found in pre-selected samples). Such theoretical values of the minimum number of cores for individual soil samplers are calculated as average values of all three fields and are related to the area of the experiment, i.e. 25 m^2 (5 × 5 m).

DISCUSSION

The obtained results suggest that for an objective survey of the species spectrum (detection of seeds of all present weeds in soil) the soil sampler with a larger diameter is useful for analyzing partial samples. However, it should be stressed that the differences between the samples taken with an agrochemical soil sampler in comparison with both larger samplers could be also caused by the different volume of the cores (10 partial samples were taken with all soil samplers regardless the diameter of the sampler used). Based on this, the soil volume of one core taken at the depth of 30 cm was 39.8 cm^3 in the agrochemical soil sampler of 1.3 cm diameter, 964.6 cm^3 in the Kalentějev soil sampler of 6.4 cm and 1 507.0 cm^3 in the soil sampler of 8.0 cm manufactured by the Ejkelkamp firm. The volume of soil taken with the soil sampler of the smallest diameter need not be sufficient to detect the species that are less frequent and of non-uniform distribution across the field.

Rahman et al. (1996), on the contrary, took the same volume of soil using different soil samplers (diameters of 2.5 and 7.5 cm). In this case, it would have been more useful to take smaller cores (using the soil sampler with a smaller diameter) because taking more samples is better to cover the area of the field examined.

Assessment of variation in results obtained

Table 6 shows that the value of the coefficient of variation (v_x) decreases along with the increasing diameter of the soil sampler. Rahman et al. (1997), who used soil samplers of 2.5 and 7.5 cm diameters, took 30 partial samples in both cases. They found out that larger cores display less variation than smaller ones. In individual weed species, the coefficient v_x increased at decreasing frequency of seeds in individual partial samples from 17.82 to 316.23%. A comparably low v_x, in both the total number of all seeds and the number of species per sample (i.e. up to ca. 50%), was assessed only in species regularly occurring in the field concerned. Cardina and Sparrow (1996) report similar values of the coefficient of variation. For instance, they found the coefficient v_x from 55 to 155% in the most frequent species. They also confirm that v_x increases at decreasing abundance (up to the values of 423 or 563%).

The minimum number of taken samples

The calculated values of the theoretical minimum number of partial samples demonstrate that their sufficient number was taken for the acceptable error of Δ_{20} only, and namely if soil samplers of 6.4 and 8.0 cm diameters were used. By contrast, when the soil sampler of 1.3 cm diameter was exploited, 24 to 39 partial samples were needed to take on the area of 25 m^2. In individual species at the mentioned acceptable error (Δ_{20}), the number of partial samples was sufficient in the soil samplers with larger

Table 6. Coefficient of variation (%) at individual sampling procedures

Field	Total number of seeds			Number of species per sample		
	soil sampler					
	1.3 cm	6.4 cm	8.0 cm	1.3 cm	6.4 cm	8.0 cm
Field 1	56.11	22.80	19.16	50.71	25.72	19.46
Field 2	45.52	24.54	20.76	43.07	17.78	14.46
Field 3	43.35	24.97	22.04	49.85	23.87	16.56

Table 7. Theoretical number of taken samples in relation to the required exactness of the total number of all seeds ($P \leq 0.05$)

Field	Acceptable error	Soil sampler (1.3 cm)	Soil sampler (6.4 cm)	Soil sampler (8.0 cm)
Field 1	Δ_5	625	103	73
	Δ_{10}	156	26	19
	Δ_{20}	39	7	5
Field 2	Δ_5	411	120	86
	Δ_{10}	103	30	22
	Δ_{20}	26	8	5
Field 3	Δ_5	382	124	96
	Δ_{10}	96	31	25
	Δ_{20}	24	8	6
Mean (fields)	Δ_5	473	116	85
	Δ_{10}	118	29	22
	Δ_{20}	30	8	5

diameters (6.4 and 8.0 cm), however, in the species that occur regularly only.

The survey below gives the calculated area in m^2 characterized by a partial sample at the corresponding acceptable error (calculated from data in Table 7, means of three fields) to capture the total number of weed seeds in soil. The theoretical minimum numbers of partial samples correspond to the experiment area of 25 m^2.

Acceptable error	Diameter of soil core sampler (cm)		
	1.3	6.4	8.0
Δ_5	0.05 m^2	0.22 m^2	0.29 m^2
Δ_{10}	0.21 m^2	0.86 m^2	1.13 m^2
Δ_{20}	0.83 m^2	3.13 m^2	5.00 m^2

The calculated values demonstrate that the area characterized by a partial sample at the acceptable error of Δ_5 is very small (0.22 and 0.29 m^2) even in the soil samplers of 6.4 and 8.0 cm diameters. To keep such precision necessitates taking a large number of partial samples, which is very hard in any type of field experiments. The obtained values confirm large heterogeneity in density of weed seeds at the distance of some tens of cm found by Dvořák (1971).

It may be concluded that one core with 8.0 cm diameter on the area of ca. 1 m^2 is optimum for the exact research (at the acceptable error of Δ_{10}). Such a density of sampling is applicable in estimation of the weed seedbank in soil on very small (1 m^2) and marked out areas.

To estimate the weed seedbank in soil in small-plot experiments, one partial sample on the area of 5 m^2 (acceptable error of Δ_{20}) can be recommended. The given data can be, to the certain extent, related to individual weed species whose seeds were most frequent in soil. These were *Amaranthus retroflexus* and *Chenopodium album* in the fields 1 and 2, and *Amaranthus retroflexus*, *Chenopodium album*, *Echinochloa crus-galli* and *Silene noctiflora* in the field 3. For the other detected species it would be necessary to take a larger amount of partial samples on the given area.

According to Šeffer (1990), it is enough to take 4 partial samples on the area of 400 m^2 (a soil sampler of 10 cm diameter) in the total number of seeds in soil or in regularly occurring species. A higher number of partial samples is necessary in the species that occur sporadically (he suggests 35 to 37). Rahman et al. (1997) refer to a possibility of overestimating reliability of data on numbers of weed seeds with less up to sporadic occurrence. They assert that in species occurring irregularly, a too high number of partial samples is needed, which is technically impossible. Another authors, Goyeau and Fablet (1982), Zanin et al. (1989), Dessaint et al. (1992, 1996), based on statistical analyses, found that the necessary number of partial samples depended on the number of weed seeds per m^2, i.e. the number of partial samples can be reduced at increasing amount of seeds. Dessaint et al. (1990, 1996) state that it is necessary to estimate hundreds of samples to achieve reliable results about numbers of weed seeds in soil. By contrast, according to Forcella et al. (1992), it is sufficient to take 10 to 20 partial samples per plot (field) at the diameter of 5.0 cm or about 25 partial samples at the diameter 2.5 cm to obtain reliable results.

When taking samples, some technical problems cannot be omitted either. In the agronomic soil sampler (1.3 cm diameter), parts of the core can come out (when samples are taken under dry conditions) because the sampler does not have a closed case. Thus, the sample volume is smaller than the theoretical one used for calculations. Such a technical failure leads to biased results (a lower number of seeds or even species).

The necessity of taking soil samples under favourable moisture relations is also supported by increasing labour consumption under dry conditions, particularly in soil samplers with a larger diameter when it is difficult to penetrate the soil. It is also very hard to withdraw the soil out of the sampler. The spring mechanism in the soil sampler Ejkelkamp makes this process easier, nevertheless, some power is necessary under such conditions. That increases the labour consumption and simultaneously decreases the labour productivity. At favourable moisture, two technicians can take about 20 to 25 samples per hour with the soil sampler of the Ejkelkamp firm at the depth of 15 cm; the performance of the Kalentějev soil sampler was half of it.

The obtained data suggest that partial samples taken with Kalentějev soil sampler (6.4 cm diameter) and the sampler of the Ejkelkamp firm (8.0 cm) provide comparable results in the estimation of the weed seedbank in soil and of the species spectrum. Further, the greater labour consumption was stressed at taking soil cores with samplers of larger diameters, particularly under dry conditions and on heavy soils. The soil sampler of the Ejkelkamp firm that was used in our experiment, is recommended for easier way of taking samples, however with a smaller diameter, ca. 6.0 cm. To assure the precision of results, it would be necessary to take a somewhat larger number of samples with this soil sampler. At the acceptable error of Δ_{20}, 8 samples vs. 5 samples taken with the soil sampler with the diameter of 8.0 cm would be necessary (25 m^2). Such an adjustment of the sampler diameter is recommended to the manufacturer. We suppose that it would contribute to wider use of this sampler not only in weed but as well as in other fields of agricultural research.

REFERENCES

Barralis G., Chadoeuf R., Gouet J.P. (1986): Essai de détermination de la taille de l'échantillon pour l'étude du potentiel semencier d'un sol. Weed Res., *26*: 291–297.

Benoit D.L., Kenkel N.C., Cavers P.B. (1989): Factors influencing the precision of soil seedbank estimates. Can. J. Bot., *67*: 2833–2840.

Cardina J., Sparrow D.H. (1996): A comparison of methods to predict weed seedling populations from the soil seedbank. Weed Res., *44*: 46–51.

Dessaint F., Barralis G., Beuret E., Caixinhas M.L., Post B.J., Zanin G. (1992): Etude coopérative EWRS: la détermination du potentiel semencier: II – estimation de la précision relative sur la moyenne á partir de composites. Weed Res., *32*: 95–101.

Dessaint F., Barralis G., Caixinhas M.L., Mayor J.P., Recasens J., Zanin G. (1996): Precision of soil seedbank sampling: how many soil cores? Weed Res., *36*: 143–151.

Dessaint F., Barralis G., Caixinhas M.L., Post B.J., Zanin G. (1990): EWRS collaborative study of weed seedbank estimation: 1. Studies of the relation between the mean and the variance with sampling procedure. Weed Res., *30*: 421–429.

Dvořák J. (1971): Weed seedbank in soil. [Dissertation.] VŠZ, Brno. (In Czech)

Dvořák J., Krejčíř J. (1974): A contribution to the study of weed seedbank in topsoil. Brno, 22 (3): 453–461. (In Czech)

Forcella F., Wilson R.G., Rener K.A., Dekker J., Harvey R.J., Alm D.A., Buhler D.D., Cardina J. (1992): Weed seedbanks of the U.S. Corn Belt: Magnitude, variation, emergence and application. Weed Sci., *40*: 636–644.

Goyeau H., Fablet G. (1982): Study of weed seedbank in soil: sampling problem. Agronomie, *2*: 545–551.

Hron F., Kohout V. (1967): Basic agronomic practices. Handbook of field weeds. SPN, Praha. (In Czech)

Rahman A., James T.K., Grbavac N., Mellsop J. (1995): Evaluation of two methods for enumerating the soil weed seedbank. Proc. 48th New Zealand Plant Protect. Conf.: 175–180.

Rahman A., James T.K., Grbavac N., Mellsop J. (1996): Spatial distribution of weed seedbank in maize cropping fields. Proc. 49th New Zealand Plant Protect. Conf.: 291–295.

Rahman A., James T.K., Waller J.E., Grbavac N. (1997): Soil sampling studies for estimation of weed seedbanks. Proc. 50th New Zealand Plant Protect. Conf., Lincoln Univ., Canterburry: 447–452.

Šeffer J. (1990): Distribution of seed bank of weeds in arable soil. Biologia, *45*: 49–60.

Thompson K., Grime J.P. (1979): Seasonal variation in the seed banks of herbaceous species in ten contrasting habitats. J. Ecol., *67*: 893–921.

Zanin G., Berti A., Zuin M.C. (1989): Estimation of the seedbank in cultivated and direct drilled systems. Weed Res., *29*: 407–417.

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ABSTRAKT

Vliv různého způsobu odběru půdních vzorků na přesnost stanovení zásoby semen plevelů v půdě

V modelovém pokusu byl sledován vliv různého způsobu odběru půdních vzorků na přesnost stanovení zásoby semen plevelů v půdě třemi sondýrkami s kruhovou základnou o průměru 1.3, 6.4 a 8.0 cm. Výsledky poukázaly na význam metodického postupu. Pro objektivní vyjádření druhového spektra (zachycení semen všech přítomných druhů plevelů v půdě) je vhodné použití sondýrky s větším průměrem. Dále bylo zjištěno, že hodnota variačního koeficientu (v_x) klesá se zvětšujícím se průměrem sondýrky. Hodnota v_x u dílčích vzorků odebraných sondýrkou s průměrem 1.3 cm byla dva- až třikrát větší než při použití sondýrek o průměru 6.4 a 8.0 cm. U jednotlivých plevelných druhů se v_x zvyšoval se snižující se četností výskytu semen v jednotlivých dílčích vzorcích v rozmezí 17.82–316.23 %. Pro exaktní výzkum je optimální jeden odběr o kruhové základně, d = 8,0 cm na plochu cca 1 m^2. Pro hodnocení zásoby semen plevelů v půdě v maloparcelních pokusech lze doporučit odebírat jeden dílčí vzorek na plochu 5 m^2. Pro získání vzájemně porovnatelných výsledků je třeba se zmenšujícím se průměrem sondýrky odebírat větší počet vzorků. Větší počet vzorků je zapotřebí pro zachycení druhů s nižším výskytem.

Klíčová slova: zásoba semen plevelů v půdě; odběr vzorků půdy; přesnost stanovení

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