Field experiment on longevity of the seeds in the soil seed bank (Joint experiment)

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DOI 10.5073/jka.2016.455.14

Introduction

Reports on seed longevity of common ragweed under natural conditions (i.e. in agricultural soils) are sparse. Toole and Brown (1946) found that seeds buried in soil can survive up to 49 years and that losses in the upper soil layers were high and longevity therefore shorter than at deeper burial depth. We started longevity experiments with common ragweed seeds from different origins in Germany, Slovenia, Hungary, Austria and Denmark in 2012. The experiments are planned to last for 10 years.

Methods

Each participating lab buried two common ragweed seed lots. Seeds from Hungary ('Kaposvar 2011') were buried in all countries. As second test population different labs used different local seed lots. At JKI: 'Domsdorf 2010', at BOKU and KU: 'Hagenbrunn 2011', and at KIS and AU: 'Unterpurkla 2010'. The year after the lot name indicates the year of seed sampling. The seeds were buried at two depths (5-8 and 25cm) either in early winter 2011 (BOKU) or in early spring 2012 (all other labs).

We buried the seeds in portions of 50 seeds each enclosed by a polyester tissue (net) (Fig. 1).

Fig. 1. Seed burial of common ragweed in polyester tissue (net) (KU-Hungary 2013)

During the next 10 years, seeds of the two populations and depths will be excavated on the 15th of March in each year or postponed if the soil is frozen until it is frost-free. The excavated seeds were tested for viability by germination test and a subsequent TTC-test – for comparison, together with regularly stored (dry at 4°C) seeds from the respective populations.

Test for viability of the buried common ragweed seeds was done in 2 steps:

First step: Germination test (Fig. 2): putting 25 seeds each on watered filter paper in petri dishes and left for 2 weeks in climate chambers running a cycle of 12 h light at 30^0 C and 12 h darkness at 15^0 C. Every second day the number of germinated seeds was counted and removed. Finally the petri dishes were opened for drying.

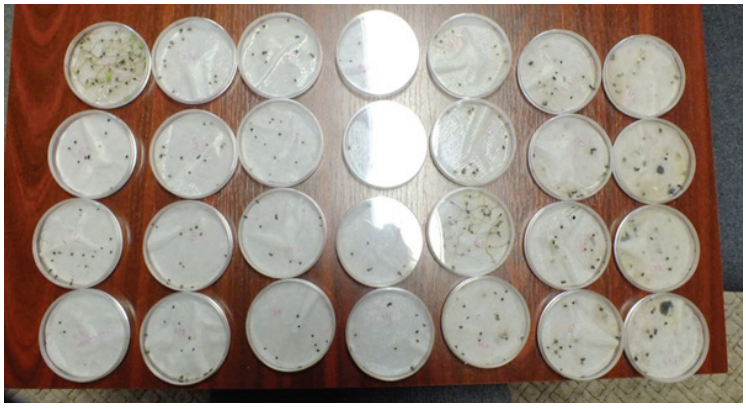

Fig 2. Laboratory germination tests in Petri dishes (KU-Hungary 2013)

Second step: non germinated seeds were subjected to a TTC-viability test following the developed protocol (see "Standard protocol for testing viability with the Triphenyl Tetrazolium Chloride Test", this issue).

The number of viable seeds was calculated as the sum of germinated seeds plus the number of fully stained non-germinated seeds (class 1) in the TTC test.

First excavation took place in March or April 2013, depending on the local climate (frozen soil).

Results

The results of the local excavations and viability tests are given here for the different labs separately.

JKI:

In Germany (JKI) more than 90% of the seeds from both populations and burial depths germinated (Fig. 3). Non-germinated seeds were tested with the TTC test and were evaluated to be dead.

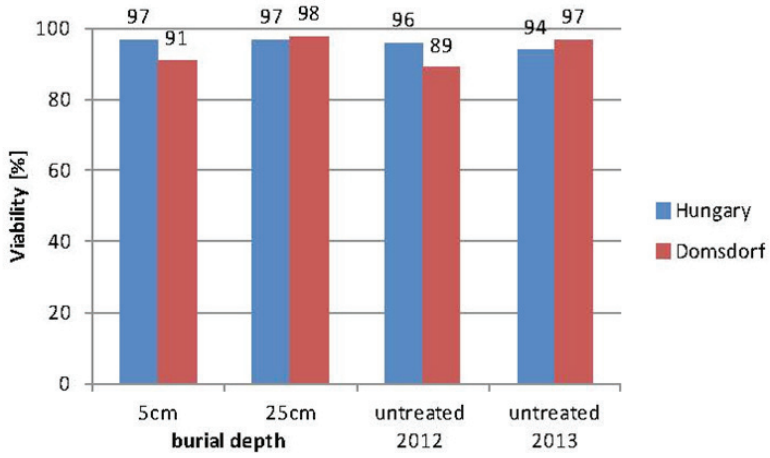

Fig. 3: Viability [%] of buried common ragweed seeds from populations (Kapsovar 2011) and Domsdorf 2010 after 1 year at 5 and 25 cm depth, and of untreated control seeds, stored at 4°C continuously (tested both in 2012 and 2013)

BOKU:

Excavation on Austrian site took place on March 22nd 2013.

Fig. 4 shows the number of viable common ragweed seeds per net from the Kaposvar 2011 burial depth of 8 versus 25 cm, differentiated by the status of viability. In both cases the number of seeds alive (germinable or positively stained) is very high. The slight tendency of higher means of viable seeds in deep soil can be recognized. This indicates the better conditions for survival of seeds in deep soil (conservation) which was documented several times for weed seeds in arable fields in the literature. The Hagenbrunn 2010 seed lot was buried in mid December but burial of Kaposvar 2011 seeds could not be continued directly afterwards because of extreme low temperatures and frozen soil.

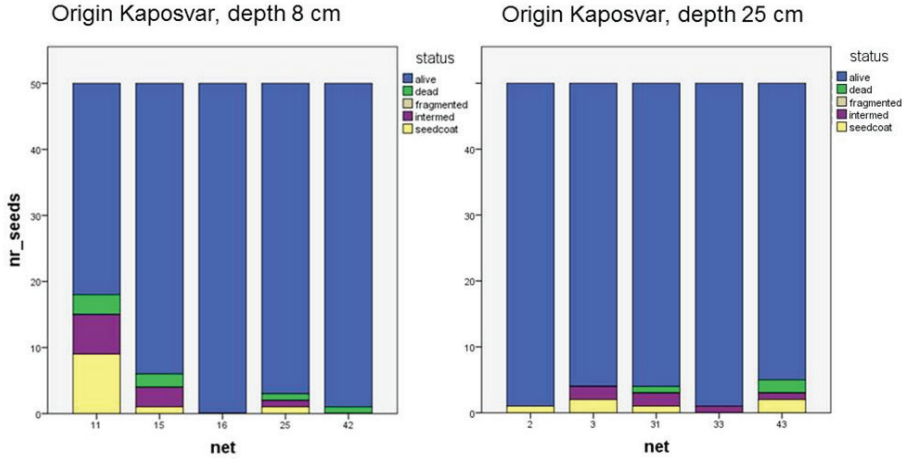

Fig. 4: Number of viable common ragweed seeds per net from the Kaposvar 2011 origin – from the burial depth of 8 cm(left) versus 25 cm (right), differentiated by the status of viability

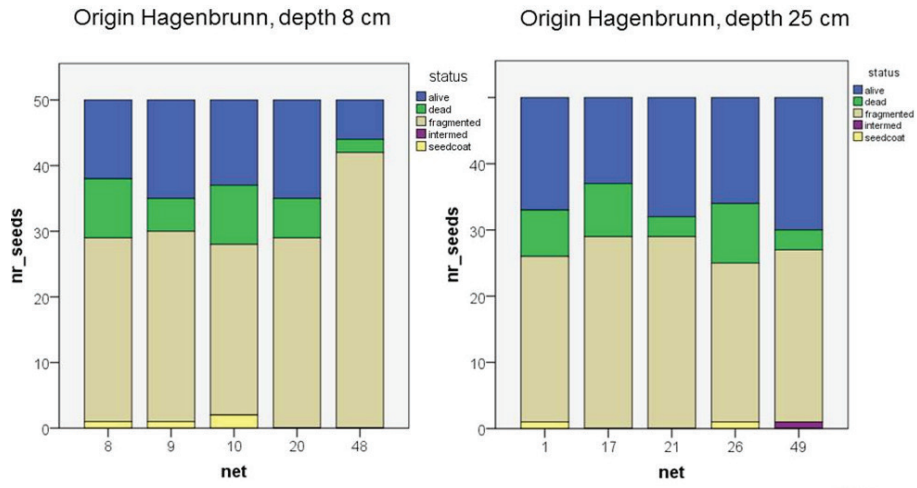

Fig. 5: Number of viable common ragweed seeds per net from the Hagenbrunn 2010 origin – from the burial depth of 8 (left) versus 25 cm (right), differentiated by the status of viability

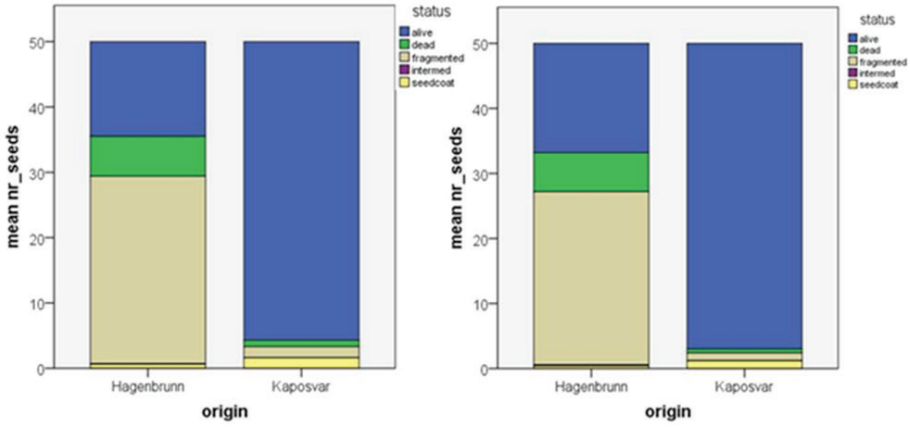

Fig. 6: Comparison of the mean number of viable common ragweed seeds per net from the origins Hagenbrunn 2010 and Kaposvar 2011 – from burial depths of 8 (left) and 25 cm (right), differentiated by the status of viability

Maybe this differing date of burial is to some extend responsible for the big difference in alive versus fragmented/dead seeds. The status "fragmented" was applied when we found only halves of seed coat or when we found not any trace of the seeds that were put into the net (lost seeds, or decomposed seeds after death or after germination in the soil substrate). The big difference of the mean number of viable seeds per net between the two origins is also illustrated by Fig. 6.

KU:

The excavated Kaposvar 2011 seeds gave different results to the Hagenbrunn 2010 ones (Table 1). The Hagenbrunn 2010 sample stored in the refrigerator gave better germination results in comparison to the seeds buried in the field.

Table 1: Germination rates and viability of common ragweed seeds buried in different depths (in % of the starting population), compared to seeds from the same seed lot stored at 4°C in darkness.

Buried (5 cm)		Buried (25 cm)		Stored in refrigerator (at 4 °C)	
Kaposvar 2011	Hagenbrunn 2010	Kaposvar 2011	Hagenbrunn 2010	Kaposvar 2011	Hagenbrunn 2010
Germination (%)					
86	30	85	48	28	50
Seed viability (%) based on TTC tests					
96	89	94	82	71	75

AU:

For the 'Kaposvar 2011' population the results from Denmark were similar to those from Germany showing a high viability of seeds irrespectively of burial depth. The results also show a tendency to seed conservation by burial compared to storage in refrigiator. The seed lot 'Unterpurkla 2010' generated much lower viability rates than 'Kaposvar 2011'.

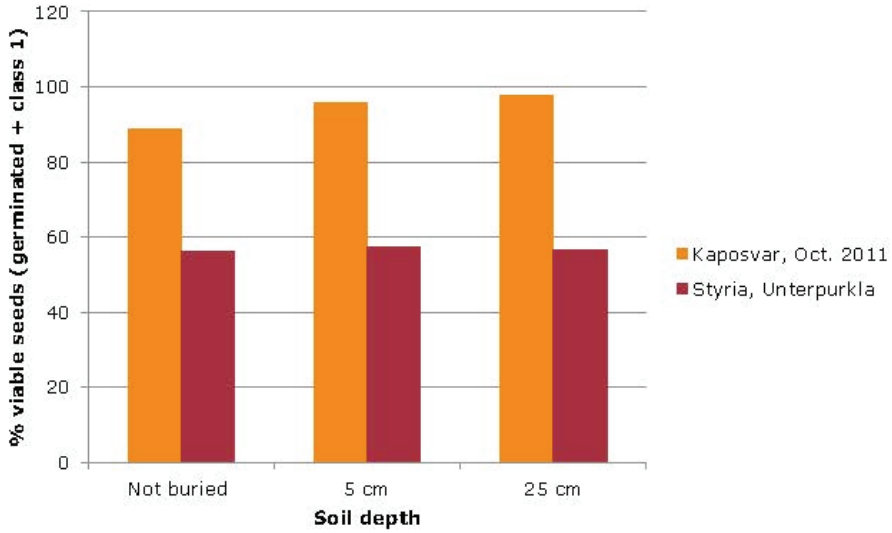

Fig. 7: Total viability (germination + TTC-test) of common ragweed seeds from 2 sources buried in 5 and 25 cm depth

KIS:

Finally, the Slovenian experimental site gave lower amount of alive seeds compared to those by the Austrian site (Fig. -11): High amounts of dead or crushed seeds.

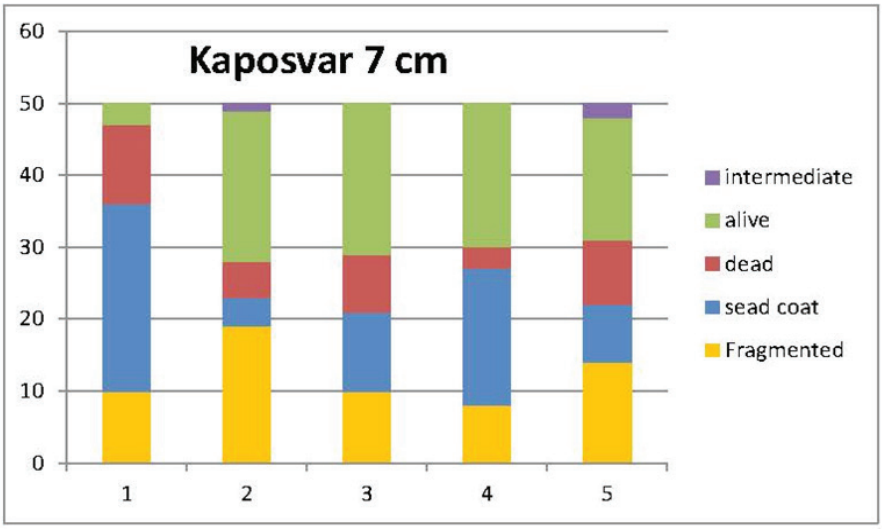

Fig. 8: Common ragweed seeds from Kaposvar 2011 buried at 7 cm in 2012 after germination and TTC test in 2013

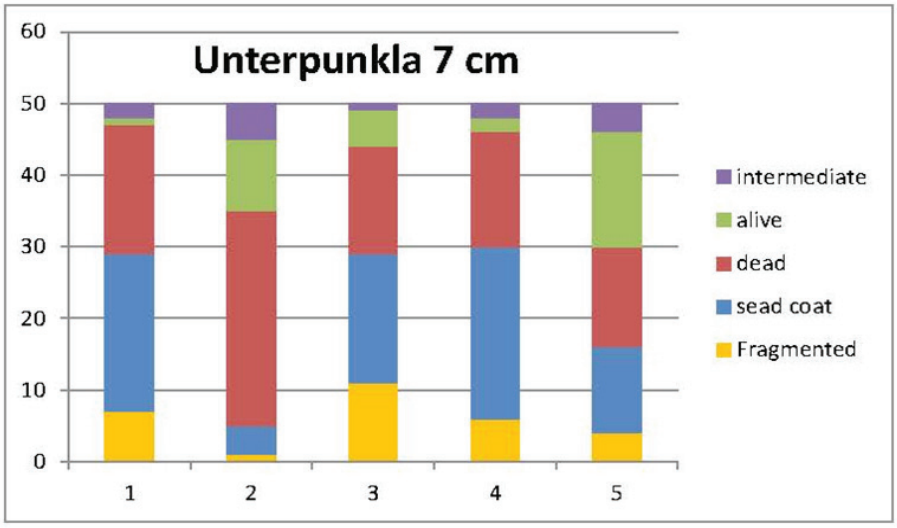

Fig. 9: Common ragweed seeds from Unterpurkla 2010 buried at 7 cm in 2012 after germination and TTC test in 2013

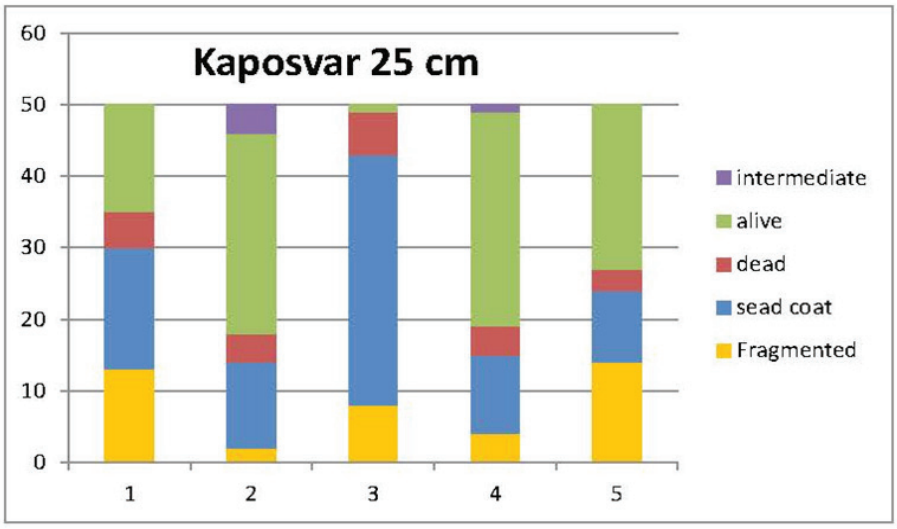

Fig. 10: Common ragweed seeds from Kaposvar 2011 buried at 25 cm in 2012 after germination and TTC test in 2013

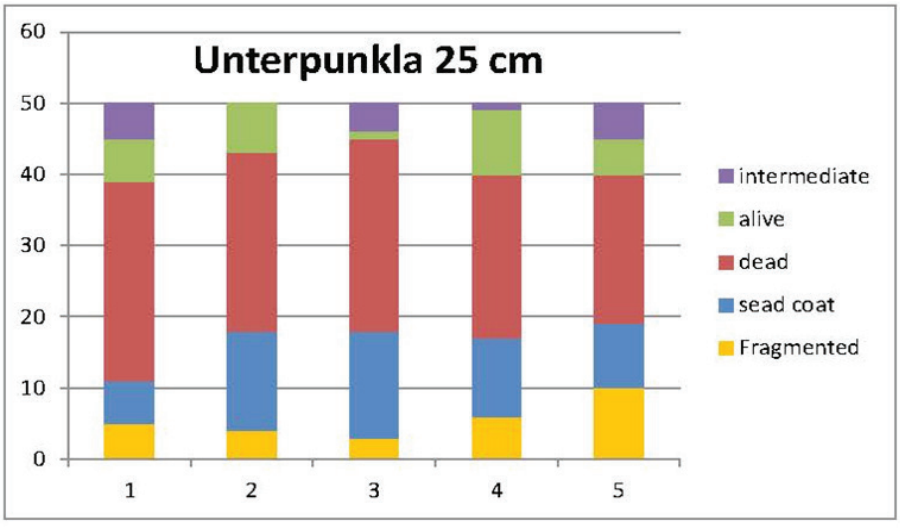

Fig. 11: Common ragweed seeds from Unterpurkla 2010 buried at 25 cm in 2012 after germination and TTC test in 2013

High variability in seed viability status of common ragweed samples was determined regardless of the seed origin and burial depth. In general the seed sample from the common ragweed population Kaposvar 2011 remained more viable compared to the Unterpurkla 2010 samples. Seed samples from both localities contained high percentage of fragmented seeds. Origin and habitat seem to be more important factors influencing viability of the seeds than burial depth.

References

Toole H.E. and Brown E. (1946): Final results of the Durvel buried seed experiment. J. Agric. Res. 72, 201-210.