

Table S1. Survival rates (%) of seeds of common ragweed: a) (left columns): seeds at dry or wet condition, and protected or unprotected, exposed to different dry heat treatment temperatures (60, 70, 80, 90, or 100 °C) for 0.5, 1, 3, 6, 12, 24, or 48 hours; b) (upper right columns): wet or dry seeds treated with hot steam or hot water (both at 90 °C) for 0.5, 1, 5, 10, 20, or 40 minutes; c) (lower right columns) seeds treated in the field with hot foam for 5 minutes unprotected (lying on the soil surface), covered with vegetation and leaf litter, or buried 1 cm in soil n = 100* seeds per factor combination; 100 % mortification is marked in grey

<i>Treatment temperature</i>								
DRY SEEDS unprotected	100°C	90°C	80°C	70°C	60°C	DRY SEEDS	Hot steam	Hot water
untreated control	100.0					untreated control	98.9	
<i>Treatment time</i>						<i>Treatment time</i>		
0.5 hours	37.4	40.0	88.0	94.9	97.0	0.5 minutes	100.0	6.1
1 hour	18.6	26.8	67.0	96.0	94.0	1 minute	10.3	3.0
3 hours	23.0	48.0	63.0	95.9	89.0	5 minutes	0.0	0.0
6 hours	26.3	28.3	73.0	91.9	86.7	10 minutes	0.0	0.0
12 hours	32.0	22.0	84.8	92.0	79.0	20 minutes	0.0	0.0
24 hours	4.0	13.0	79.0	88.0	96.0	40 minutes	0.0	0.0
48 hours	1.2	16.0	65.0	89.9	97.0			
DRY SEEDS protected	100°C	90°C	80°C	70°C	60°C	DRY SEEDS	Hot foam	
untreated control	99.0					untreated control	94.9	
<i>Treatment time</i>						<i>Treatment</i>		
0.5 hours	92.9	86.9	94.9	94.7	97.8	unprotected	75.0	
1 hour	92.0	78.4	91.9	94.8	92.6	vegetation cover	88.0	
3 hours	78.5	49.5	87.2	86.5	89.6	in 1 cm soil depth	75.0	
6 hours	53.9	43.8	92.6	87.2	89.0			
12 hours	33.3	51.0	82.1	84.4	92.8			
24 hours	28.4	53.6	94.6	81.9	96.7			
48 hours	14.9	40.4	91.3	73.2	95.8			
WET SEEDS unprotected	100°C	90°C	80°C	70°C	60°C	WET SEEDS	Hot steam	Hot water
untreated control	97.0					untreated control	98.9	
<i>Treatment time</i>						<i>Treatment time</i>		
0.5 hours	48.5	71.1	87.0	96.9	95.0	0.5 minutes	85.9	2.0
1 hour	6.7	7.1	29.2	75.8	87.0	1 minute	2.0	0.0
3 hours	1.1	3.0	18.0	47.5	59.8	5 minutes	0.0	0.0
6 hours	2.2	4.2	7.1	14.1	66.3	10 minutes	0.0	0.0
12 hours	0.0	0.0	4.2	12.2	44.2	20 minutes	0.0	0.0
24 hours	0.0	0.0	0.0	11.1	36.4	40 minutes	0.0	0.0
48 hours	0.0	0.0	0.0	13.5	55.0			
WET SEEDS protected	100°C	90°C	80°C	70°C	60°C	WET SEEDS	Hot foam	
untreated control	86.0					untreated control	97.0	
<i>Treatment time</i>						<i>Treatment</i>		
0.5 hours	80.4	94.7	95.8	94.7	91.6	unprotected	39.5	
1 hour	89.5	77.6	90.8	77.2	90.4	vegetation cover	43.5	
3 hours	41.8	51.0	85.4	91.5	89.8	in 1 cm soil depth	0.0	
6 hours	3.1	50.5	64.9	76.3	96.9			
12 hours	0.0	43.9	70.9	73.7	85.3			
24 hours	0.0	36.1	61.1	59.0	84.4			
48 hours	0.0	15.5	44.8	64.2	84.5			

*Seeds which were visibly intact but turned out to be empty when opened (no embryo developed) were excluded from the results as the viability of these seeds was not affected by the heat treatments; total number of seeds per factor combination varies between 98 and 100 seeds

Table S2. Survival rate (%) of dry and wet seeds of narrow-leaved ragwort (protected and unprotected) after exposure to different treatment temperatures (60, 70, 80, 90, 100°C) for 0.5, 1, 3, 6, 12, 24, and 48 hours, after treatment with hot steam and hot water (both. 90°C) for 0.5, 1, 5, 10, 20, and 40 minutes, and after treatment with hot foam for 5 minutes unprotected (lying on the soil surface), covered with surrounding vegetation or buried 1 cm in soil n= 100* seeds per factor combination; 100 % mortification is marked in grey

DRY SEEDS unprotected	Treatment temperature					DRY SEEDS	Hot steam	Hot water
	100°C	90°C	80°C	70°C	60°C			
untreated control	92.0					untreated control	98.0	
Treatment time						Treatment time		
0.5 hours	67.7	84.0	89.0	90.0	86.0	0.5 minutes	100.0	0.0
1 hour	71.3	88.0	90.0	100.0	85.0	1 minute	33.3	0.0
3 hours	82.0	94.1	90.0	96.0	85.6	5 minutes	22.0	0.0
6 hours	49.0	81.0	90.1	92.0	85.0	10 minutes	1.0	0.0
12 hours	83.2	80.0	84.0	99.0	84.3	20 minutes	0.0	0.0
24 hours	49.0	75.0	91.0	95.0	91.9	40 minutes	0.0	0.0
48 hours	22.0	66.3	82.0	96.0	88.0			
DRY SEEDS protected	Treatment temperature					DRY SEEDS	Hot foam	
	100°C	90°C	80°C	70°C	60°C			
untreated control	97.0					untreated control	95.0	
Treatment time						Treatment		
0.5 hours	99.0	94.0	87.1	100.0	91.0	unprotected	95.0	
1 hour	94.0	91.0	91.0	97.0	85.7	vegetation cover	0.0	
3 hours	92.0	88.0	84.0	97.0	88.0	in 1 cm soil depth	0.0	
6 hours	95.0	84.0	93.0	94.0	92.0			
12 hours	97.0	86.1	93.0	95.0	85.1			
24 hours	76.0	83.0	83.0	98.0	88.9			
48 hours	39.0	68.0	88.0	93.0	86.1			
WET SEEDS unprotected	Treatment temperature					WET SEEDS	Hot steam	Hot water
	100°C	90°C	80°C	70°C	60°C			
untreated control	96.0					untreated control	97.0	
Treatment time						Treatment time		
0.5 hours	0.0	0.0	0.0	72.2	94.0	0.5 minutes	15.0	0.0
1 hour	0.0	0.0	0.0	46.0	82.0	1 minute	27.7	0.0
3 hours	0.0	0.0	0.0	30.0	98.0	5 minutes	0.0	0.0
6 hours	0.0	0.0	0.0	14.9	97.0	10 minutes	0.0	0.0
12 hours	0.0	0.0	0.0	56.0	90.0	20 minutes	0.0	0.0
24 hours	0.0	0.0	0.0	40.4	95.9	40 minutes	0.0	0.0
48 hours	0.0	0.0	0.0	56.0	88.7			
WET SEEDS protected	Treatment temperature					WET SEEDS	Hot foam	
	100°C	90°C	80°C	70°C	60°C			
untreated control	92.0					untreated control	97.0	
Treatment time						Treatment		
0.5 hours	0.0	0.0	28.0	93.0	84.0	unprotected	49.0	
1 hour	0.0	0.0	29.0	77.6	84.4	vegetation cover	0.0	
3 hours	0.0	0.0	38.4	70.0	94.0	in 1 cm soil depth	0.0	
6 hours	0.0	0.0	45.5	66.0	96.0			
12 hours	0.0	0.0	23.0	52.0	86.6			
24 hours	0.0	0.0	29.2	66.0	82.0			
48 hours	0.0	0.0	37.4	79.2	88.0			

*Seeds which were visibly intact but turned out to be empty when opened (no embryo developed) were excluded from the results as the viability of these seeds was not affected by the heat treatments; total number of seeds per factor combination varies between 97 and 100 seeds

Table S3. Survival rate (%) of dry and wet seeds of giant hogweed (protected and unprotected) after exposure to different treatment temperatures (60, 70, 80, 90, 100°C) for 0.5, 1, 3, 6, 12, 24, and 48 hours, after treatment with hot steam and hot water (both. 90°C) for 0.5, 1, 5, 10, 20, and 40 minutes, and after treatment with hot foam for 5 minutes unprotected (lying on the soil surface), covered with surrounding vegetation or buried 1 cm in soil n= 100* seeds per factor combination; 100 % mortification is marked in grey

<i>Treatment temperature</i>								
DRY SEEDS unprotected	100°C	90°C	80°C	70°C	60°C	DRY SEEDS	Hot steam	Hot water
untreated control	85.0					untreated control	91.0	
<i>Treatment time</i>						<i>Treatment time</i>		
0.5 hours	67.0	76.0	82.0	84.7	91.9	0.5 minutes	84.9	0.0
1 hour	51.0	72.7	79.8	79.8	89.8	1 minute	56.1	0.0
3 hours	35.0	62.2	72.3	75.8	88.8	5 minutes	0.0	0.0
6 hours	12.1	60.0	75.3	83.7	82.8	10 minutes	0.0	0.0
12 hours	0.0	47.0	36.4	79.6	81.0	20 minutes	0.0	0.0
24 hours	0.0	7.0	36.0	79.4	78.0	40 minutes	0.0	0.0
48 hours	0.0	0.0	33.0	64.3	72.0			
DRY SEEDS protected	100°C	90°C	80°C	70°C	60°C	DRY SEEDS	Hot foam	
untreated control	87.0					untreated control	87.0	
<i>Treatment time</i>						<i>Treatment</i>		
0.5 hours	73.0	85.0	85.9	85.7	94.9	unprotected	79.8	
1 hour	54.1	84.0	83.8	85.9	92.9	vegetation cover	31.0	
3 hours	43.0	75.0	76.0	79.6	84.9	in 1 cm soil depth	0.0	
6 hours	22.0	65.3	70.7	78.8	82.7			
12 hours	0.0	59.2	63.6	77.8	80.6			
24 hours	0.0	8.0	67.7	72.5	75.5			
48 hours	0.0	0.0	46.5	62.6	68.3			
WET SEEDS unprotected	100°C	90°C	80°C	70°C	60°C	WET SEEDS	Hot steam	Hot water
untreated control	86.0					untreated control	86.0	
<i>Treatment time</i>						<i>Treatment time</i>		
0.5 hours	0.0	13.0	71.0	67.0	85.0	0.5 minutes	0.0	0.0
1 hour	0.0	0.0	65.7	46.9	83.8	1 minute	0.0	0.0
3 hours	0.0	0.0	0.0	53.0	70.7	5 minutes	0.0	0.0
6 hours	0.0	0.0	0.0	4.1	76.5	10 minutes	0.0	0.0
12 hours	0.0	0.0	0.0	0.0	73.3	20 minutes	0.0	0.0
24 hours	0.0	0.0	0.0	0.0	60.6	40 minutes	0.0	0.0
48 hours	0.0	0.0	0.0	0.0	61.6			
WET SEEDS protected	100°C	90°C	80°C	70°C	60°C	WET SEEDS	Hot foam	
untreated control	86.0					untreated control	86.0	
<i>Treatment time</i>						<i>Treatment</i>		
0.5 hours	76.0	78.0	71.0	91.8	91.9	unprotected	80.0	
1 hour	0.0	25.3	65.0	89.8	88.0	vegetation cover	0.0	
3 hours	0.0	0.0	0.0	30.3	87.9	in 1 cm soil depth	0.0	
6 hours	0.0	0.0	0.0	28.6	74.8			
12 hours	0.0	0.0	0.0	31.6	71.4			
24 hours	0.0	0.0	0.0	31.0	72.7			
48 hours	0.0	0.0	0.0	5.1	67.0			

*Seeds which were visibly intact but turned out to be empty when opened (no embryo developed) were excluded from the results as the viability of these seeds was not affected by the heat treatments; total number of seeds per factor combination varies between 99 and 100 seeds

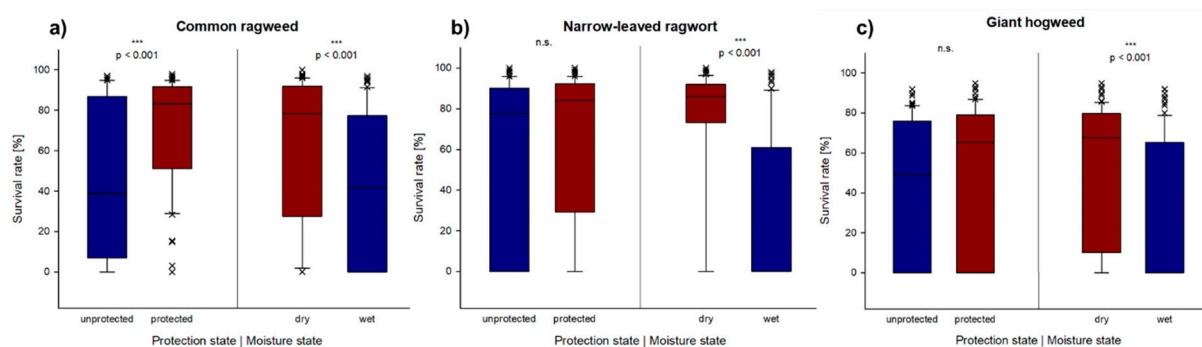


Figure S1: Seed survival rate (%) after dry air heat treatment in lab of a) common ragweed, b) narrow-leaved ragwort, and c) giant hogweed in relation to the seed protection state (unprotected = air heated; protected = incorporated in soil) and to the moisture