The effect of parsley seed hydration treatment and pelleting on seed vigour

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ABSTRACT

The effect of two priming techniques: hardening (prehydration treatment) and solid matrix priming (SMP) was studied on the seeds of two parsley varieties (Cukrowa and Berlińska) in 3-year laboratory experiments. On the images obtained from scanning electron microscope (SEM) there is a parsley embryo developing during germination up to the moment of radicle emergence. On the surface of primed seeds, in particular using the hardening method, lateral cracks are visible. The respiratory activity of primed seeds was similar to that of non-primed in the period of initial 24 h of germination, but significantly higher after 48 h. As compared to non primed seeds solid matrix priming significantly increased the percentage and the speed of germination. Nevertheless, pelleting reduced the positive effect of priming on the germination ability, without affecting the germination speed. After 18 months of storage, the vigour of primed seeds, particularly through hardening, had significantly decreased.

Keywords: priming; parsley seeds; vigour

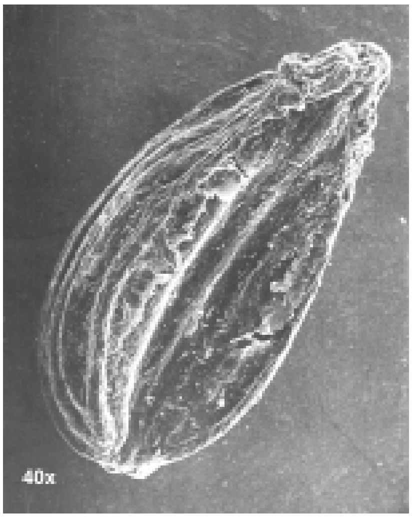
The root parsley seeds (*Petroselinum sativum* Hoff. ssp., *microcarpum*) are characterised by low and slow germination. Numerous researchers have reported improving seed quality through osmo-conditioning with polyethylene glycol (PEG) 6000 or 8000 (Pill 1986). However, osmo-conditioning also has some negative effect by intensifying the development of seed-born fungi and the fungi appearance in the course of osmo-conditioning. The solid matrix priming (SMP) is based on regulation of water availability to seeds by means of a solid substance (Taylor et al. 1988). When the treatment is applied to seeds of low vigour level, SMP is very effective (Khan et al. 1990) as opposed to osmo-conditioning with PEG, which in this case proves to be ineffective (Tylkowska and Biniek 1996). Chrobak and Podlaski (1993) used chemically inactive ceramic rubbles as a solid substance for priming carrot seeds using the SMP method. This treatment increased speed and percentage of seed germination. This paper studies the effectiveness of parsley seed priming.

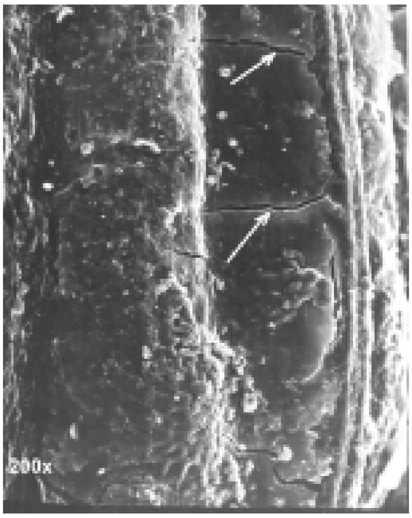
MATERIAL AND METHODS

Two cultivars: with shorter Cukrowa and longer Berlińska periods of vegetation were studied in 3-year laboratory experiments. Two methods of priming were employed: 1. hardening (prehydration treatment): the seeds were mixed with water (1:1 w/v) in closed containers (without aeration), incubated for 72 h at 20°C and then dried at room temperature and 2. solid matrix priming (SMP). The SMP method was employed with two different solid substances: substance A (chemically inactive ceramic rubbles with granule diameter of 3–3.5 mm) and chemically active substance B (ion exchange between seeds and water saturated substance B was observed in the course of priming) of 2–3.5 mm of granule diameter. Each substance was mixed with water to achieve complete saturation. 1 g of parsley seeds with their original water content (7.8%) was mixed with 8 g of water saturated substance A (humidity 31.4%, water potential –0.46 MPa) and in case of SMP B – with 30 g of substance B (humidity 27%, water potential –0.44 MPa). The mixtures of seeds and solid substance in closed containers were incubated for 72 h at 20°C, dried at room temperature until the seeds reached their original water content (about 7.8%). Seeds were separated from solid substance with an air separator. Control (non-primed) seeds, hardened seeds and seeds solid matrix primed with substance B were pelleted. Beech powder with particles of 0.1 mm in diameter was used as a basic substance of pellet. The following combinations were studied: non-pelleted seeds: control (non primed), hardened, solid matrix primed in substance A (SMP A), solid matrix primed in substance B (SMP B) and pelleted seeds: control (non primed), hardened, solid matrix primed in substance B (SMP B). The increase of water content and changes of the water potential of the primed non pelleted seeds, in conditions of water shortage in seedbed, were monitored. The seeds were put onto Petri dishes on an oil blotter (70% humidity of blotting paper full water capacity FWC and water potential –0.75 MPa). The water content (measured using the dryer method) and water potential of seeds were measured after 1, 2.5, 4 and 24 h after the start of the germination test. Water potential was measured using Wescor HR 33 T, Sample Chamber C-52. The scannig electron microscope (SEM) images were taken by M.Gromadka, Electron Microscope Laboratory of Warsaw Agricultural University. The respiratory activity of non-primed and primed seeds was measured during 96 h of germination using LI – COR CO_2 Analyzer, LI – 6200 DMP LTD. The germination ability was measured at 20°C using the Jacobsen set up. The water content of blotter was 100% FWC and its water potential –0.66 MPa. Germinated seeds (radicles exceeding 1 mm in length) were counted every day. The Pieper coefficient (the mean time of single seed germination, Pieper 1952) was taken as the measure of germination speed. In order to estimate the phyto-sanitary effect of chemically active substance B, the fungi inhabitation of SMP B primed seeds was examined in four replicates, using the two tests. 1. Roll Test (RT): 25 seeds were placed in a row on a double layer of a blotter soaked with sterile water and covered by 1.2% maltose-agar medium. The seeds were covered with a stripe of a blotter, rolled and incubated for 8 days at 20°C. After 8 days the degree of infection with seed born fungi was evaluated. 2. The Deep Freezing Blotter Test (DFBT): 25 seeds were placed on Petri dished of 12 cm diameter, on two layers of a blotter soaked with sterile water and incubated for 24 h at 20°C, then for 24 h at –20°C and for 8 days at 20°C with a 12 h dark/12 h light cycle (NUV ~360 nm). Non-pelleted primed and control (non-primed) parsley seeds were subjected to the controlled deterioration test (Hampton and TeKrony 1995). Vigour of control and primed seeds was evaluated after 6, 12 and 18 months of storage in a temperature of 20°C with 60% air humidity.

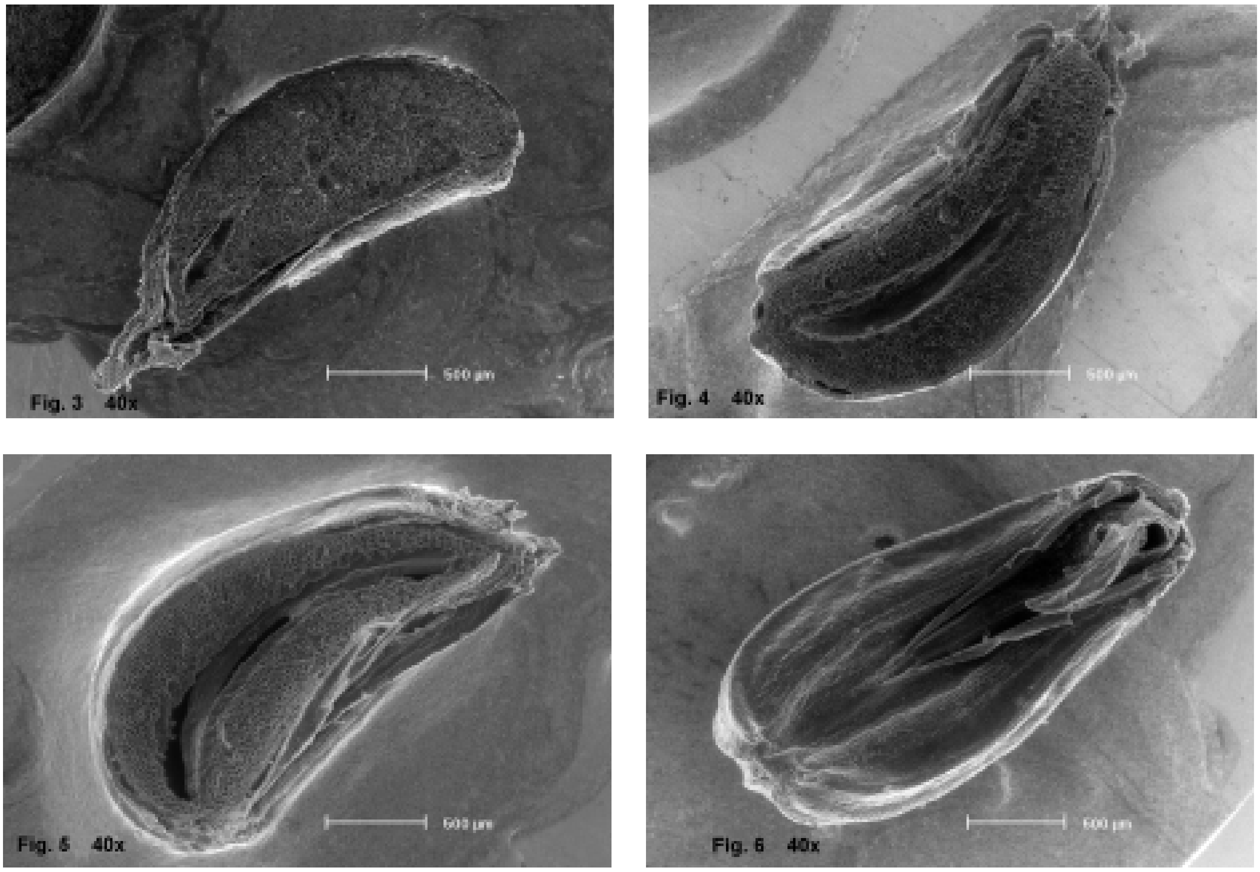
RESULTS

In conditions of water shortage in a seedbed (70% Full Water Capacity of blotting paper) the absorption of water was the most rapid in the case of seeds matrix primed with substance B (35.8%). This fact was evident after only 1 h of contact with the seedbed. After the following 24 h the water content of SMP B treated seeds was the same (52.6%) as that of hardened (51.1%) and control seeds (53.2%), while the water content of SMP A treated seeds was significantly lower (46.6%, *LSD* = 2.68%). The lowest water potential after 1 h contact with the seedbed was noted in control seeds (–3.04 MPa). The water potential values of the primed seeds were significantly higher [(–1.87) – (1.73) MPa], despite the water shortage in the seedbed. The water potential of control seeds increased consistently faster than that of primed seeds, although after 24 h significant differences between water potentials observed earlier had vanished [control seeds (–1.0) MPa, primed seeds (–1.1) – (–0.93) MPa]. The SEM images of the external surface of control (non-primed) and primed seeds showed apparent cracks in the case of the latter (Figures 1 and 2). Analysis of the surface conducted on 20 control seeds (non-primed), primed using hardening and SMP B showed the presence of cracks in 1, 12 and 5 seeds correspondingly. Figures 3–6 show parsley embryo developing during the germination. An embryo of roughly 0.8 mm in length is surrounded by endosperm cells (Figure 3), filled with starch grains (Figure 7). Figure 4 shows an embryo already several times larger. Seed leaves (cotyledons) are becoming visible. Figure 5 shows an embryo just before the emergence of radicle. Seed leaves, peak-bud and radicle are visible. The developing embryo destroyed endosperm cells. Inside the endosperm cells remained small number grains of starch (Figure 8). Resulting free space around the embryo can be seen in Figure 5. Figure 6 shows radicle emerging outside the seed. Among the priming techniques applied hardening and SMP B treatment for cv. Cukrowa and SMP A for cv. Berlińska were more effective after 10 days of germination (Table 1). After 28 days of germination all priming treatments applied to cv. Cukrowa were significantly more effective compared to control seeds, while in the case of cv. Berlińska only SMP A significantly improved the percentage of germination ability. Analysis of the average results from both varieties indicate that the best effects when compared with control seeds were achieved through SMP A, that led to the significant increase of the germination ability after 10 and 28 days by





Figures 1 and 2. Imbibitional damage (→) of primed seeds



Figures 3–6. Stages of embryo development during seed germination

7.2% and 4.9%, respectively. Results of measurements of the respiratory activity of control (non-primed) and primed parsley seeds in the initial 96 h of germination were presented in Figure 9. Until 24 h of germination the graph curves were similar, although respiratory activity of primed seeds was slightly (insignificantly) higher in comparison with non-primed seeds. After 48 h of germination the respiratory activity of primed seeds was significantly higher in comparison with non-primed seeds. Correlation coefficient between the seed humidity and their respiratory activity equalled: for non-primed seeds 0.9466, for primed seeds 0.7874. In general, pelleting of the seeds decreased the germination ability, although hardened pelleted seeds germinated better than control pelleted seeds, while SMP B treatment had no effect (cv. Cukrowa) or even decreased the germination ability as in case of Berlińska cv. The analysis of the three-year results from both cultivars after 10 and 28 days of germination leads to the conclusion that pelleting reduces positive effects of priming. All priming techniques improved the speed of

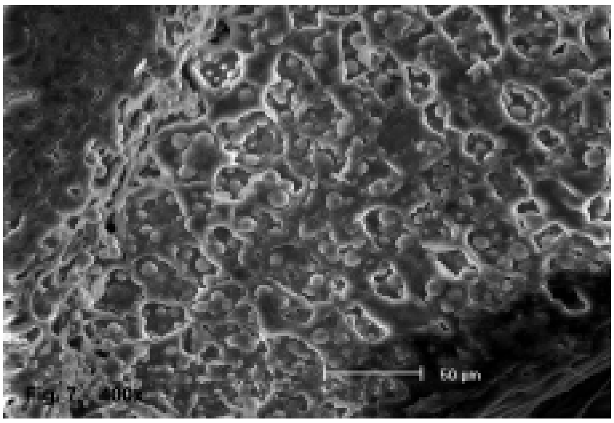


Figure 7. Cells of endosperm with well visible starch grains

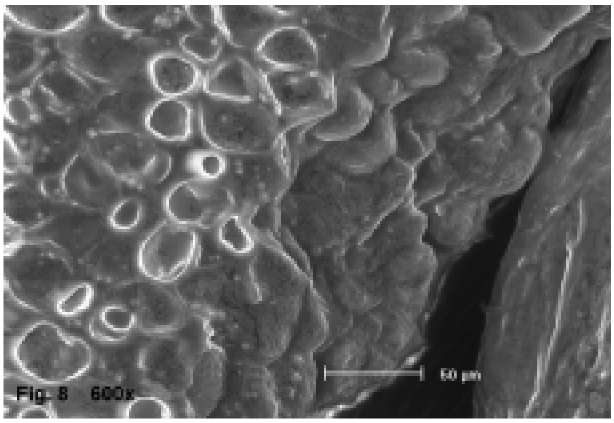


Figure 8. Endosperm cells destroyed by the developing embryo; small number of starch grains inside endosperm cells

Table 1. The effect of seed treatment on the germination ability of parsley two varieties (cvs. Cukrowa and Berlińska); hardening, SMP A, SMP B – ways of priming technique; average from 3-year experiments

Seed treatment	Germination ability (%) after days 10		Germination ability (%) after days 28		Average from varieties after days	
	Cukrowa	Berlińska	Cukrowa	Berlińska	10	28
			Non pelleted seeds			
1. control	60.9 bc	52.7 b	64.3 b	60.0 b	56.8 b	62.2 b
2. hardening	66.6 a	55.0 b	68.8 a	60.8 b	60.8 ab	64.8 ab
3. SMP A	65.7 ab	62.3 a	68.4 a	65.8 a	64.0 a	67.1 a
4. SMP B	66.4 a	54.6 b	69.0 a	60.8 b	60.5 ab	64.9 ab
			Pelleted seeds			
5. control	57.0 c	54.5 b	62.5 b	65.8 a	55.8 b	64.2 ab
6. hardening	61.6 b	54.6 b	67.4 ab	62.9 a	58.1 b	65.2 ab
7. SMP B	59.8 b	48.3 c	62.1 b	53.5 c	54.1 b	57.8 b
LSD $\alpha = 0.05$	4.1	3.8	3.4	3.2	4.4	4.8

Means followed by the same letter are not significantly different according to Duncan's test

germination and pelleting did not affect this positive effect (Table 2). The speed of germination of control seeds of the two varieties both pelleted and non-pelleted was always lower (higher Pieper coefficient) than that of the other combinations. After 10 and 28 days, the speed of germination of either SMP A or SMP B treated seeds was the highest in the case of both cultivars. Pelleting reduced the differences between the speed of germination of control and primed seeds although the speed of germination of primed seeds was always higher than that of the control seeds. Almost 100% of the parsley seeds were inhabited with *Alternaria alternata* and neither priming nor pelleting changed the degree of inhabitation. The number of *Alternaria petroselini* colonies on the seedlings from pelleted primed seeds was lower than from the control seeds. The ability and speed of germination of non-primed seeds (control sample), evaluated after 6, 12 and 18 months of storage, did not vary significantly. In turn, primed seeds maintained the same level of germination only during 6 months of storage. After 12 and 18 months of storage the germination ability of primed seeds had significantly decreased by 9.9–14.1% and 19.0–25.2% correspondingly in relation on to the original value, and the Pieper coefficient increased significantly by 0.7–1.0 and 0.8–1.8 days correspondingly. Most of all for seeds primed through hardening (by 1.8 days). These results complied with those obtained from the controlled deterioration test conducted on seeds before storage.

DISCUSSION

The results indicate that the effectiveness of seed priming of two parsley varieties differed. This complies with the results obtained by Brocklehurst and Dearman (1983), who concluded that response to given priming treatment can vary not only between cultivars, but even between seed lots of the same cultivar. Accelerating germination through seed priming mainly using the SMP method was achieved by many authors quoted by Pill (1995). Priming, particularly hardening increased the sensitivity of parsley seeds to deterioration. The number of seeds with cracked surfaces differed according to the priming techniques used. The authors suspect that it was connected with the imbibitional damage associated with rapid water absorption. According to Pill (1995) solid matrix priming may be more suitable than osmotic or water priming (hardening) for seeds susceptible to imbibitional or chilling injury.

The results of CO_2 emission during 96 h of germination might suggest that primed seeds have a greater potential to re-establish structural integrity and synthesise new compounds more rapidly during the early stages of imbibition than non- primed seeds (Pill 1986). The number of *Alternaria petroselini* colonies on the SMP B primed seeds was lower before as well as after pelleting. This suggests a positive effect of priming using this technique. Treating parsley seeds with solid matrix prim-

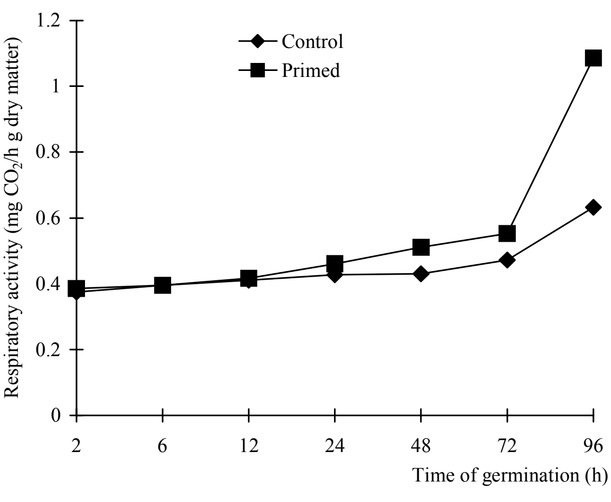


Figure 9. Respiratory activity of primed and non-primed parsley seeds during the 96 h after start of germination test

Table 2. The effect of seed treatment on Pieper coefficient of parsley two varieties (cvs. Cukrowa and Berlińska); hardening, SMP A, SMP B – see Table 1; average from 3-year experiments

Seed treatment	Pieper coefficient (days) after days 10		28		Average from varieties after days	
	Cukrowa	Berlińska	Cukrowa	Berlińska	10	28
Non pelleted seeds						
1. control	6.8 ab	6.1 b	7.6 a	6.6 a	6.5 a	7.1 a
2. hardening	5.4 c	4.7 d	6.1 c	5.0 c	5.1 c	5.6 c
3. SMP A	4.9 d	4.6 de	5.3 d	4.9 d	4.8 c	5.1 d
4. SMP B	5.2 cd	4.3 e	6.0 c	4.5 d	4.8 c	5.3 cd
Pelleted seeds						
5. control	7.1 a	6.6 a	7.8 a	6.8 a	6.8 a	7.3 a
6. hardening	6.2 b	5.4 c	6.8 b	6.0 b	5.8 b	6.4 b
7. SMP B	6.5 b	5.3 c	7.0 b	5.4 c	5.9 b	6.2 b
LSD $\alpha = 0.05$	0.4	0.3	0.4	0.4	0.4	0.4

Means followed by the same letter are not significantly different according to Duncan's test

ing led to the positive effects similar to those obtained by treating carrot seeds (Chrobak and Podlaski 1993). SMP is a method sufficiently simple to apply, and separation of seeds from solid substances was not problematic.

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ABSTRAKT

Vliv hydratačního ošetření a peletizace osiva petržele na jeho vitalitu

Byl studován vliv dvou způsobů hydratačního ošetření osiva kořenové petržele, prehydratace a priming v pevné fázi (SMP). Výzkum byl realizován u dvou odrůd (Cukrowa a Berlińska) ve třech pokusných letech. Na snímcích z elektronového mikroskopu (SEM) je uveden vývoj embrya v období klíčení až do fáze prorůstání kořínku. Na povrchu hydratovaných semen, zejména při použití metody prehydratace, jsou viditelné laterální praskliny. Intenzita dýchání hydratovaných semen byla v počáteční 24h periodě klíčení stejná jako u neošetřených semen, ale po 48 h klíčení byla průkazně vyšší. V porovnání s neošetřenou kontrolou priming v pevné fázi průkazně zvyšuje procento a rychlost klíčení. Avšak následná peletizace snižuje pozitivní vliv primingu na klíčivost, rychlost klíčení naopak neovlivňuje. Po 18 měsících skladování se vitalita semen ošetřených primingem, zejména prehydratací, průkazně snižovala.

Klíčová slova: priming; osivo petržele; vitalita

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