Effect of parsley seed treatment on root yield

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ABSTRACT

As parsley seed vigour is known to be low, a 3-year field study was conducted to examine the effectiveness of seed priming and pelleting. Hardening and solid matrix priming (SMP) were applied to two varieties (Cukrowa and Berlińska). Both methods of seed pre-sowing treatment increased the percentage, speed and synchrony of seedling emergence. Due to seed pre-treatment the original root yield of cv. Cukrowa increased by 6.45 to 7.09 t/ha and that of cv. Berlińska by 2.44 to 5.48 t/ha, depending on the priming technique. Pelleting of primed seeds negatively affected seed vigour as compared to the primed non-pelleted seeds.

Keywords: parsley seed; pelleting; priming; emergence; root yield

There are three characteristic indices of field emergence: percentage, speed and synchrony. The percentage of parsley seedling emergence ranged from 13.6 to 49.6% depending on climatic conditions. Field emergence of parsley does not start sooner than 2.5 weeks after sowing and lasts for 3 weeks at least (Sokołowska et al. 1994), and sometimes even for 60 days (Rabin et al. 1988). The relation between seed quality and yield is not often obvious. The latter may depend on the impact of seed quality on crop establishment. According to Te Krony and Egli (1991) the effect of seed vigour on yield is higher in plants with shorter vegetation period and in those harvested during the vegetation phase, e.g. lettuce, carrot. The effect of seed vigour on biological yield is low, but it is high on commercial yield because of an additional effect of seed vigour on the variability of morphological parameters of plants. Taking into consideration the low seed vigour of parsley an attempt was made to determine the effectiveness of different pre-sowing treatments of parsley seeds on seedling emergence and root yield.

MATERIAL AND METHODS

Three-year field experiments were conducted with two varieties Cukrowa and Berlińska. Pre-sowing treatment techniques included the following combinations: non-pelleted seeds = control, hardening, SMP A, SMP B primed seeds. Two methods of priming were employed: hardening (prehydration treatment) and solid matrix priming (SMP) with two different solid substances: substance A chemically inactive ceramic rubbles with granule diameter of 3–3.5 mm and chemically active substance B of 2–3.5 mm granule diameter (Podlaski et al. 2003). Pelleting was applied to control, hardened and SMP B treated seeds. The field experiments were conducted in random blocks in four replications on Experimental Farm Zelazna co Skierniewice. The seeds were sown in the second half of April each year, except in 1996 when sowing had to be repeated on May 16th because of pouring rains. Cereals were forecrops each time. Plants were cultivated according to the recommendations given by Bejo Zaden Polska. Each year two separate experiments were conducted:

1. To estimate field emergence 125 seeds were sown with Wintersteiger sowing machine on 3.2 m. The emerged seedlings were counted every second day and marked by putting a tag to each seedling so as to determine the percentage, speed and synchrony of emergence. Speed and emergence synchrony were expressed as the values of Pieper coefficient (Pieper 1952). When assessing the speed of emergence, the sowing day is assumed to be the first day of emergence, when the uniformity of emergence is assessed, the first day of emergence is the day when the first seedling emerged.
2. To estimate root yield, seeds were sown in grooves 75 cm apart with Gasparo sowing machine. Seeds in each groove were sown in 2 rows, 8 cm apart. The seeds were dressed with a mixture of Apron, Rowral and Funaben before sowing. The plot (one replication) consisted of 4 grooves 6 m long. The sowing norm was 1.6 millions seeds per ha. Crop establishment was estimated at two random grooves 3 m long.

RESULTS AND DISCUSSION

The percentage of seedling emergence was very low and ranged in cv. Cukrowa from 7.6% in 1996 to 38.2% in 1994 (Table 1). The field emergence percentage of both cultivars was the lowest (14.1–14.9%) in 1996, when the weather conditions were very unfavourable because of drought. The best results were obtained with the seeds primed by hardening. For cv. Cukrowa the emergence percentage was significantly higher in 1994, 1995 and 1996 – by 13.1, 9.5 and 8.8%, respectively, as compared to control seeds. Cv. Berlińska responded differently to priming in different years. In 1994 the best results were obtained with the seeds treated either with SMP A or

Table 1. The effect of seed treatment on field emergence percentage of two parsley varieties (Cukrowa and Berlińska) compared to their germination ability

Seed treatment*	Field emergence (%)								Average for varieties
	Cukrowa				Berlińska				
	1994	1995	1996	mean	1994	1995	1996	mean	
Non-pelleted seeds									
1.	25.1 bc	27.1 bc	7.6 b	19.9 b	20.1 b	22.0 c	11.6 c	17.9 c	18.9 b
2.	38.2 a	36.6 a	16.4 a	30.4 a	25.4 ab	25.6 ac	22.0 a	24.3 ab	27.4 a
3.	37.1 a	23.2 c	18.4 a	26.2 a	26.8 ab	23.0 bc	15.2 bc	21.7 abc	24.0 ab
4.	30.1 b	29.4 b	19.6 a	26.3 a	30.2 a	30.4 a	18.0 ab	26.2 a	26.3 a
Pelleted seeds									
5.	20.6 c	24.6 bc	10.4 b	18.5 b	21.3 b	19.2 c	13.2 bc	17.9 c	18.2 b
6.	21.2 c	23.8 c	16.0 a	20.3 b	25.2 ab	27.8 a	12.4 c	21.8 abc	21.1 b
7.	25.0 b	24.4 bc	10.4 b	19.9 b	21.3 b	24.0 bc	11.6 c	19.0 bc	19.5 b
LSD $\alpha = 0.05$	6.2	5.1	4.8	5.1	5.8	5.2	4.8	5.3	4.8
Germination ability (%) after 28 days (average for 1–7 seed treatments, laboratory experiments)									
Non-pelleted seeds	70.0	67.5	65.3	67.6	64.3	61.3	59.8	61.8	
Pelleted seeds	67.0	63.3	62.0	64.1	62.9	60.3	58.9	60.7	

* 1. control, 2. hardening, 3. SMP A, 4. SMP B, 5. control, 6. hardening, 7. SMP B
one-variable analysis; the values followed by the same letter are not significantly different according to Duncan's test ($P > 0.05$)
Hardening, SMP A, SMP B = priming techniques; 3-year field and laboratory experiments

SMP B, in 1995 SMP B priming was the most effective, while in 1996 hardening and SMP B. In both cultivars an average from 3 years of both SMP treatments resulted in an insignificant decrease of field emergence (1.1–3.4%) compared to the seeds primed by hardening. However, in general each seed treatment technique applied for 3 years significantly increased field emergence percentage as compared to the non-treated seeds.

Pelleting of seeds abolished a positive effect of priming. In 1994–1996 the differences in the average field emergence percentage from pelleted seeds were insignificant.

The speed of emergence ranged from 15.4 to 38.7 days, depending on the year and seed treatment technique (Table 2). It means that especially in 1995 individual seedlings were still emerging 2 months after sowing. For both cultivars, in 1994 and 1995 seed priming increased the speed of emergence from 2.4 to 5.0 days as compared to control seeds. In 1996, natural priming of sown seeds took place due to pouring rains. The effect of pre-sowing

Table 2. The effect of parsley seed treatment on Pieper coefficient (speed of emergence) of two varieties (Cukrowa and Berlińska)

Seed treatment*	Pieper coefficient (day)								Average for varieties
	Cukrowa				Berlińska				
	1994	1995	1996	mean	1994	1995	1996	mean	
Non-pelleted seeds									
1.	22.5 a	34.9 a	16.4 b	24.6 a	28.1 b	36.5 b	17.4 a	27.3 ab	26.0 a
2.	20.1 b	29.9 c	16.3 bc	22.1 b	25.2 c	33.7 c	16.1 b	25.0 b	23.6 b
3.	19.8 bc	31.0 bc	15.9 bc	22.2 b	26.1 c	33.7 c	17.5 a	25.8 b	24.0 b
4.	18.7 c	30.2 c	15.7 bc	21.5 b	24.8 c	35.4 bc	15.7 b	25.3 b	23.4 b
Pelleted seeds									
5.	20.2 b	32.7 b	18.1 a	23.7 ab	27.6 bc	36.4 b	17.7 a	27.2 ab	25.5 ab
6.	19.1 bc	30.9 bc	15.6 bc	21.9 b	28.5 b	36.1 b	17.4 a	27.3 ab	24.6 a
7.	18.6 c	31.8 bc	15.4 c	21.9 b	30.2 a	38.7 a	17.9 a	28.9 a	25.4 a
LSD $\alpha = 0.05$	1.3	1.8	0.9	1.7	1.5	1.8	0.8	1.8	1.5

* 1. control, 2. hardening, 3. SMP A, 4. SMP B, 5. control, 6. hardening, 7. SMP B
one-variable analysis; the values followed by the same letter are not significantly different according to Duncan's test ($P > 0.05$)
Hardening, SMP A, SMP B see Table 1; 3-year field experiments

Table 3. Field emergence synchrony of differently treated parsley seeds of two varieties (Cukrowa and Berlińska)

Seed treatment*	Synchrony of emergence (days)							
	Cukrowa				Berlińska			
	1994	1995	1996	mean	1994	1995	1996	mean
Non-pelleted seeds								
1.	12.5 ab	13.0 a	9.5 ab	11.6 a	13.1 a	14.5 a	9.9 a	12.5 ab
2.	10.5 bc	7.3 c	8.5 b	8.8 b	11.5 b	12.0 b	8.1 b	10.5 b
3.	9.1 c	9.1 bc	8.5 b	8.9 b	11.6 b	11.6 b	8.3 b	10.5 b
4.	9.1 c	7.8 b	8.2 b	8.5 b	10.8 b	12.4 b	8.0 b	10.4 b
Pelleted seeds								
5.	13.2 a	11.7 ab	10.0 a	11.6 a	12.9 a	14.4 a	10.3 a	12.5 ab
6.	11.1 b	7.9 b	8.8 a	9.3 a	12.6 a	14.2 ab	10.2 a	12.3 ab
7.	10.8 bc	9.7 b	8.7 b	9.7 a	13.0 ab	15.9 a	10.9 a	13.3 a
LSD $\alpha = 0.05$	1.8	2.2	1.2	2.3	1.4	1.9	1.5	8.0

* 1. control, 2. hardening, 3. SMP A, 4. SMP B, 5. control, 6. hardening, 7. SMP B
one-variable analysis; the values followed by the same letter are not significantly different according to Duncan's test ($P > 0.05$)
Hardening, SMP A, SMP B see Table 1; 3-year field experiments

priming was insignificant in cv. Cukrowa while in the case of cv. Berlińska seed priming by hardening or SMP B had a positive effect on the speed of field emergence. Seed pelleting decreased the differences in the speed of emergence of differently treated seeds. During 3 years, hardening as well as SMP B combined with pelleting led to a significant increase (average 1.8 day) of the speed of field emergence of cv. Cukrowa as compared to the control pelleted seeds. In the case of non-pelleted seeds the differences ranged from 2.4 to 3.1 days. Pelleting of the cv. Berlińska primed seeds practically had no influence on the speed of field emergence. Average speed of field emergence of cv. Berlińska primed seeds was almost the same or sometimes lower as compared to control seeds.

Emergence synchrony ranged from 7.3 to 15.9 days depending on the variety, year and treatment technique (Table 3). Seed priming of both varieties resulted in a significant increase of the seedling emergence synchrony. The best results were obtained by the SMP B treatment. On average for the two cultivars non-pelleted seeds treated with SMP B increased emergence synchrony in the course of 3 years: i.e. 3.1 days for cv. Cukrowa and 2.1 days for cv. Berlińska. Pelleting of primed seeds decreased emergence synchrony, reducing it to the level of non-primed and non-pelleted seeds.

Biological root yield of cv. Cukrowa ranged from 13.78 to 26.64 t/ha depending on the year and applied technique (Table 4). Each year seed priming increased root yield

Table 4. The effect of seed treatment on the biological root yield of two parsley varieties (Cukrowa and Berlińska)

Seed treatment*	Root yield (t/ha)								Mean from averages
	Cukrowa				Berlińska				
	1994	1995	1996	mean	1994	1995	1996	mean	
Non-pelleted seeds									
1.	17.50 d	16.06 c	13.78 e	15.78 c	18.23 c	17.59 b	19.34 c	18.39 b	17.09 c
2.	22.40 ab	19.50 a	25.05 a	22.32 a	23.44 a	20.03 ab	25.21 a	22.89 a	22.61 a
3.	23.44 a	18.54 b	26.64 a	22.87 a	22.92 a	20.37 a	24.87 a	22.72 a	22.80 a
4.	23.75 a	20.47 a	22.47 b	22.23 a	22.40 ab	18.29 b	21.59 b	20.76 a	21.50 ab
Pelleted seeds									
5.	20.00 c	18.70 b	16.62 d	18.44 b	20.63 b	17.57 b	23.85 ab	20.68 ab	19.56 b
6.	21.77 b	17.49 bc	19.09 c	19.45 b	20.94 b	20.68 a	21.65 b	21.09 a	20.27 b
7.	21.35 bc	17.51 bc	17.19 d	18.68 b	16.25 d	13.03 c	19.98 b	16.42 b	17.55 c
LSD $\alpha = 0.05$	1.51	1.46	1.81	2.11	1.81	1.81	2.22	2.31	2.0

* 1. control, 2. hardening, 3. SMP A, 4. SMP B, 5. control, 6. hardening, 7. SMP B
one-variable analysis; the values followed by the same letter are not significantly different according to Duncan's test ($P > 0.05$)
Hardening, SMP A, SMP B see Table 1; 3-year field experiments

Table 5. Correlation coefficients between root yield and crop establishment (1), and root yield and root weight (2) of two parsley varieties (Cukrowa and Berlińska)

	1994	1995	1996
1. root yield (t/ha) vs. crop establishment (number of plants/ha)			
Cukrowa	–0.57**	0.47*	0.88**
Berlińska	–0.75**	0.25	0.66**
2. root yield (t/ha) vs. root weight (g)			
Cukrowa	–0.055	0.59**	–0.53**
Berlińska	–0.008	0.55**	–0.30

* significant at 0.05, ** significant at 0.01

from 0.7 to 12.86 t/ha. In 1995 and 1996 the effects of priming techniques differed significantly. In 1995 the best effects were obtained by SMP B treatment while in 1996 by SMP A treatment and by hardening. Priming of the cv. Cukrowa seeds resulted in an increase of root yield on average by 6.45 to 7.09 t/ha, i.e. by 32.3 to 35.5%. However, pelleting of either control or primed seeds decreased the differences in root yield caused by priming. Only in 1996 the pelleted seeds of cv. Cukrowa following hardening, yielded significantly better than the control and SMP B treated seeds. The 3-year experiments allow to conclude that in cv. Cukrowa the positive effects of priming were abolished after pelleting. However, root yields from control pelleted seeds of both cultivars were significantly higher than those of non-pelleted seeds even though pelleting decreased both the percentage and speed of field emergence. Depending on the applied priming technique and year of experiment the root yield of cv. Berlińska ranged from 13.03 to 25.12 t/ha. Each year both hardening and SMP A treatment resulted in a significant (2.44 up to 5.87 t/ha) increase of root yield. The effect of SMP B treatment in 1995 and in 1996 was insignificant. However in a 3-year time each priming technique led to a significant increase of biological root yield (by 2.4 to 4.5 t/ha, i.e. by 12.9 to 24.5%) as compared to the control seeds. Similarly like in cv. Cukrowa, pelleting of the cv. Berlińska control seeds resulted in a significant increase of root yield in 1994 and 1996 as well as on average for 3 years. However the root yield from pelleted seeds that had been treated with SMP B was significantly (4.26 t/ha) lower than that of control seeds. Average root weight varied significantly in the subsequent experimental years while the differences between the cultivars were insignificant. In 1994, 1995 and 1996 the average root weight from both cultivars varied: 55–64 g, 56–60 g and 90–106 g, respectively. Crop establishment depended mainly on the emergence percentage. The 3-year average crop establishment amounted to 350 000 plants/ha of cv. Cukrowa and 320 000 plants/ha of cv. Berlińska. Each priming treatment resulted in a significant increase of cv. Cukrowa crop establishment (100 000–180 000 plants/ha) but in the case of cv. Berlińska it was insignificant and ranged from 60 000 to 130 000 plants/ha. Pelleting of primed seeds reduced the positive effect of priming: the crop establishment of the pelleted seeds was almost the same as that of the control non-pelleted seeds. Evaluation of the correlation between the yield and crop establishment at harvest and between the yield and root weight indicated that crop establishment was mainly responsible for root yield. The values of the coefficients of correlation between the root yield and the crop establishment ranged from 0.25 to 0.88 (Table 5). It was only once (in 1995) when the value of the correlation coefficient between the yield and the root weight was significant ($r = 0.55–0.59$).

The obtained results support a well-known fact that the insignificant differences in seed vigour, expressed as germination ability, can result in significant differences in the percentage of field emergence (Basu 1995). The differences found in germination ability of differently treated seeds (Podlaski et al. 2003) were below 10 per cent while the differences in the percentage of field emergence were above 200 per cent. Seed treatment positively influenced percentage, speed and synchrony of parsley field emergence. In total it had a positive effect on root yield (Finch Savage 1995). Similar effects of seed priming were obtained by other authors. The obtained results suggest that SMP treatment of parsley seeds appears to be an effective technique for improving seed quality. The problem of the low percentage of parsley field emergence can be solved if properly pelleted primed seeds of more than 0.9 mm size (Sokołowska et al.1994) are used for sowing. Nowadays numerous firms are introducing primed seeds to the market. Priming is especially recommended before pelleting. Recent studies on beet seed pelleting show that this treatment decreased both: the speed and uniformity of field emergence. Seed priming can reduce negative effects of pelleting.

REFERENCES

Basu R.N. (1995): Seed viability. In: Basra A.S. (ed.): Seed quality. Basic mechanisms and agricultural implications. Food Prod. Press, London, Chapter 1: 1–32.

Finch Savage W.E. (1995): Influence of seed quality on crop establishment, growth and yield. In: Basra A.S. (ed.): Seed quality. Basic mechanisms and agricultural implications. Food Prod. Press, London, Chapter 11: 361–376.

Pieper H. (1952): Das Saatgut. Berlin.

Podlaski S., Chrobak Z., Wyszkowska Z. (2003): The effect of parsley seed hydration treatment and pelleting on seed vigour. Plant Soil Environ., *49*: 114–118.

Rabin J., Berkowitz B., Ackers S.W. (1988): Field performance of osmotically primed parsley seed. Hort Sci., *23*: 554–555.

Sokołowska A., Szafirowska A., Janas R., Kołosowski S., Woyke H. (1994): Wpływ wielkości nasion na kiełkowanie i wschody pietruszki (*Petroselinum crispum* var. *tuberosum*). Biul. IHAR, (192): 143–153.

Te Krony D.M., Egli D.B. (1991): Relationship of seed vigour to crop yield. A review. Crop. Sci., *31*: 816–822.

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ABSTRAKT

Vliv ošetření osiva na výnos kořenové petržele

Skutečnost, že vitalita osiva petržele je nízká, vedla k výzkumu účinnosti primingu a peletizace semen formou tříletého polního pokusu. U osiva dvou odrůd (Cukrowa a Berlińska) byl testován vliv prehydratace a primingu v pevné fázi (SMP) na výnos kořenů. Obě metody předseťového ošetření osiva zvyšovaly procento a rychlost polní vzcházivosti a vyrovnanost vzcházení. Ošetřením osiva se zvyšoval původní výnos odrůdy Cukrowa o 6,45 až 7,09 t/ha a u odrůdy Berlińska o 2,44 až 5,48 t/ha, a to v závislosti na způsobu primingu. Kombinace primingu s následnou peletizací ovlivnila negativně vitalitu osiva v porovnání s variantou bez peletizace.

Klíčová slova: osivo petržele; peletizace; priming; polní vzcházivost; výnos kořenů

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