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CORRELATIONS BETWEEN GERMINATION CAPACITY AND SELECTED PROPERTIES OF PARSNIP SEEDS (*PASTINACA SATIVA* L.)

Zdzisław Kaliniewicz*, Krzysztof Jadwisieńczak, Dariusz Choszcz, Ewelina Kolankowska, Mariusz Przywitowski, Daniel Śliwiński

Department of Mills and Methodology of Research, University of Warmia and Mazury in Olsztyn

Contact details: ul. Oczapowskiego 11, 10-719 Olsztyn, e-mail: zdzislaw.kaliniewicz@uwm.edu.pl

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ABSTRACT

Critical transport velocity, basic dimensions (length, width and thickness) and the mass of parsnip seeds were determined. The resulting values were used to calculate the geometric mean diameter, aspect ratio, sphericity index and specific seed mass. A seed germination test was carried out, the results were checked every 12 hours, and the germination rate index was determined for each seed. The above parameters and indices were compared with the use of the independent t-test and correlation analysis. Germinated and non-germinated seeds differed significantly only in their thickness. A certain improvement in seed germination capacity can be achieved by separating lighter seeds from heavier seeds. In the study, the achievement of 65% germination capacity resulted in the loss of 27% germinating seeds.

List of symbols:

C_g – germination capacity, (%)
D_g – geometric mean diameter, (mm)
m – seed mass, (mg)
m_D – specific seed mass, $(g \cdot m^{-1})$
R – aspect ratio, (%)
S – standard deviation of trait,
T, W, L – seed thickness, width and length, (mm)
T_g – time required to produce a healthy germ, (days)
T_o – duration of germination test, (days)
v – critical transport velocity of particles, $(m \cdot s^{-1})$
V_g – seed viability, (%)
V_s – coefficient of trait variability, (%)
W_g – germination rate index,
x, x_{max}, x_{min} – average, maximum and minimum value of trait,
Φ – sphericity index, (%)

Introduction

Parsnip (*Pastinaca sativa L.*) is a biennial plant which, in its wild form, colonizes habitats in temperate regions. It is predominantly found along roads, streams, in forests and meadows (Berenbaum and Zangerl, 2006; Tokarska-Guzik et al., 2012). Parsnip thrives on deep, sandy loam soils rich in calcium and potassium. Parsnip, a member of *Apiacea* family*,* produces a tuberous root in the first year of cultivation and flowering stems in the second growing season. The fruits are flattened schizocarps comprising two achenes. Parsnip seeds mature in the second half of July (Orłowski et al., 1993; *Polowa*… 2000). The edible taproot is white, gray, yellow or brown-yellow. Parsnips have three times the nutritional value of carrots, they are a rich source of minerals (potassium, calcium, phosphorus and iron), vitamins (C, B1, B2, E, PP) and carotene, and they are a highly recommended snack for people suffering from obesity, atherosclerosis and cardiovascular diseases. All parts of the plant contain aromatic essential oils, and parsnips can be consumed on their own or in combination with other food products (Matuszkiewicz, 2006; Zangerl et al., 2008).

During cultivation, every seed handling operation leads to the loss of seeds, and the greatest losses are noted during harvest and cleaning. The weight of the seed bulk can be reduced by as much as 50% during cleaning and sorting (Orłowski et al., 1993; *Polowa*… 2000).

The quality of crops is influenced by both genetic and environmental factors (Górnik and Grzesik, 1998; Nik et al., 2011). The latter include the chemical composition of soil, fertilization, water availability, temperature, light exposure, and location of seeds on the plant (Schopfer et al., 2001; Martinez-Villaluenga et al., 2010; Grzesik et al., 2012; Gruszecki, 2013). Seed germination efficiency can be improved with the involvement of chemical, physical and physiological treatments, such as seed dressing, pelleting, conditioning, irradiation and electromagnetic field stimulation (Andreoli and Khan, 2000; Schopfer et al., 2001; Podleśny, 2004; Lynikiene et al., 2006; Ciupak et al., 2007; Kornarzyński and Pietruszewski, 2008; Muszyński and Gładyszewska, 2008; Domoradzki and Korpal, 2009; Maroufi and Farahani, 2011; Grzesik et al., 2012; Jamil et al., 2012; Krawiec et al., 2012). The results of laboratory and field studies (Vera, 1997; Domoradzki et al., 2002; Mut and Akay, 2010; Hojjat, 2011; Nik et al., 2011; Sadeghi et al., 2011; Ahirwar, 2012; Amin and Brinis, 2013) indicate that germination efficiency is determined by the dimensions and mass of seeds. Larger and heavier seeds germinate faster and more abundantly, which contributes to a higher crop yield. Seed germination seems to be most highly correlated with seed mass because plump seeds contain more nutrients for sprouting. The above observations were confirmed by studies investigating the germination capacity of tree seeds (Shankar, 2006; Upadhaya et al., 2007; Norden et al., 2009; Kaliniewicz et al., 2012a; 2012b).

There is a general scarcity of the published data on the correlations between the physical parameters of parsnip seeds vs. their germination capacity and viability. Those relationships should be investigated and described in detail to maximize the efficiency of seed cleaning and sorting processes and produce seed material of the highest quality.

Objective of the study

The objective of this study was to determine correlations between the physical parameters of parsnip seeds and their germination capacity to maximize the efficiency of the seed separation process.

Material and methods

The experimental material comprised seeds of a parsnip cultivar characterized by semi-long, white roots, grown in a farm in Dobielno (52,17ºN, 18,85ºE). Seeds were supplied in the amount of 1,211 kg to the TORSEED S.A. Horticultural Seed Production Company in Toruń where they were sorted in the Super Petkus K-541 cleaner (upper screen – ≠ 2.4 mm, lower screen – ø2.7 mm, seed grader – ø2.5 mm). Graded seeds were characterized by 98.5% purity, 9.4% relative moisture content and 57% germination capacity. The analyzed material did not meet ISTA quality standards applicable to seeds that are intended for retail distribution: minimum 97% purity, maximum 10% relative moisture content, and minimum 70% germination capacity. A sample of approximately 1 kg was halved, and one half was randomly selected for successive halving (*Nasiennictwo…,* 1995). The above procedure was repeated to produce samples of the minimum 150 seeds each. The analytical sample comprised 160 seeds.

The physical parameters of parsnip seeds were determined with the use of Petkus K-293 pneumatic classifier, MWM 2325 laboratory microscope, dial thickness gauge and WAA 100/C/2 laboratory scale in accordance with the methods described by Kaliniewicz et al. (2012a). Seed weight W and seed length L are presented in figure 1, and seed thickness T was the dimension perpendicular to seed length and seed width.

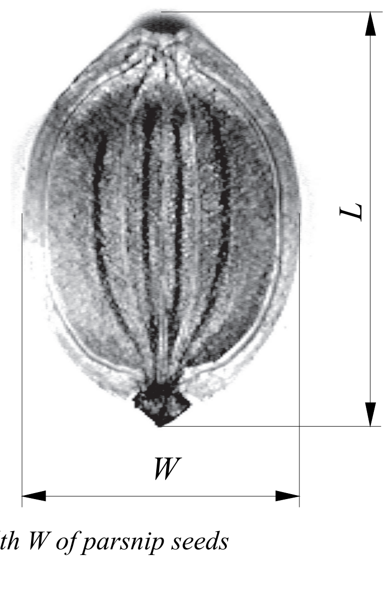

Figure 1. Length L and width W of parsnip seeds

The following parameters were calculated for every seed:
– Geometric mean diameter, aspect ratio and sphericity index (Mohsenin, 1986):

$$D_g = (T \cdot W \cdot L)^{1/3} \tag{1}$$

$$R = \frac{W}{L} \times 100 \tag{2}$$

$$\Phi = \frac{(T \cdot W \cdot L)^{1/3}}{L} \times 100 \tag{3}$$

– specific mass (Kaliniewicz, 2013):

$$m_D = \frac{m}{D_g} \tag{4}$$

– germination rate index:

$$W_g = \frac{T_o + 1 - T_g}{T_o + 1} \tag{5}$$

A germination test was carried out by placing parsnip seeds on moistened filter paper in a container with a glass lid. Evaporated water was supplemented daily with a sprinkler. The experiment was performed under exposure to natural light at a temperature of 25ºC. Germination progress was evaluated daily between 8 and 9 a.m. Seeds that produced sprouts with a minimum length of 75% seed length were classified as germinated (*Nasiennictwo…,* 1995). Observations were continued for 14 full days (12 to 26 June). Seed viability V_g and germination capacity C_g were determined as the ratio of the number of seeds that had sprouted in 7 and 14 days to the number of seeds in the analyzed sample.

The results were processed statistically in Statistica v. 10 application with the use of the independent t-test and correlation analysis (Rabiej, 2012) at a significance level of 0.05.

Results and Discussion

The physical parameters and the calculated indices of parsnip seeds are presented in Table 1. The highest value of the coefficient of variation was reported for the germination rate index (approximately 87%), and the lowest – for the sphericity index (9.5%). In the group of analyzed physical properties, the greatest variation was noted in seed mass (approximately 33.5%), and the smallest variation – in seed length (approximately 13.5%). The variation in the physical attributes of seeds exceeded 10%, which indicates that the analyzed material was diverse and that the sampling method was effective. Basic seed dimensions varied in the following ranges:
– thickness – from 0.40 to 1.11 mm,
– width – from 2.45 to 4.94 mm,
– length – from 3.01 to 6.22 mm.

Table 1
Distribution of physical properties and calculated indices of parsnip seeds

Property / index	x_{min}	x_{max}	x	S	V_s
v	1.38	3.58	2.50	0.399	16.00
T	0.40	1.10	0.66	0.094	14.23
W	2.45	4.94	3.67	0.541	14.77
L	3.01	6.22	4.63	0.625	13.51
m	0.9	9.0	4.36	1.459	33.45
D_g	1.60	2.79	2.22	0.225	10.13
R	52.36	114.55	76.76	10.942	13.72
Φ	38.89	73.65	48.45	4.603	9.50
m_D	0.43	4.00	1.98	0.688	34.79
W_g	0	0.667	0.305	0.265	86.85

The mean thickness of parsnip seeds was similar to that of *plantago ovata* (Ahmadi et al., 2012), common alder (Kaliniewicz and Trojanowski, 2011), dill, carrot, bell pepper, tomato, leek and celery seeds (Orłowski et al., 1993). In terms of mean width, parsnip seeds resembled spring barley (Hebda and Micek, 2007), cucumber, bell pepper and spinach seeds (Orłowski et al., 1993). The mean length of parsnip seeds was similar to that of flax (Pradhan et al., 2010) and coriander seeds (Coşkuner and Karababa, 2007). Mean seed mass was higher than that noted by Gruszecki (2013) and Hendrix (1984), which testifies to the plumpness of the analyzed seeds. The evaluated seeds were similar to flax seeds in terms of their geometric mean diameter (Pradhan et al., 2010), and to *plantago ovata* seeds in terms of their sphericity index (Ahmadi et al., 2012).

The analyzed seeds were characterized by germination energy of V_g=35.6% and germination capacity of C_g=62.5%. The evaluated material did not meet minimum germination capacity requirements for seed distribution (65%) (Orłowski et al., 1993). Our results suggest that germination can be improved through seed treatment. A seed quality can be improved by separating non-germinating seeds, parameters of which differ from those of germinating seeds.

The results of the independent t-test (fig. 2) indicate that germinated and non-germinated seeds differed only in thickness, and non-germinated seeds were characterized by smaller thickness. No significant differences in the remaining physical parameters and indices were observed between groups, but non-germinated seeds were characterized by lower critical transport velocity, mass, sphericity index and specific mass, and greater width and aspect ratio in comparison with germinated seeds. The reported differences in the mean thickness of germinated and non-germinated seeds could indicate that germination efficiency can be improved by sorting seeds with the use of mesh screens with longitudinal openings. A detailed analysis of separation efficiency of the thinnest seeds with anticipated 5% loss of germinating seeds did not confirm that hypothesis.

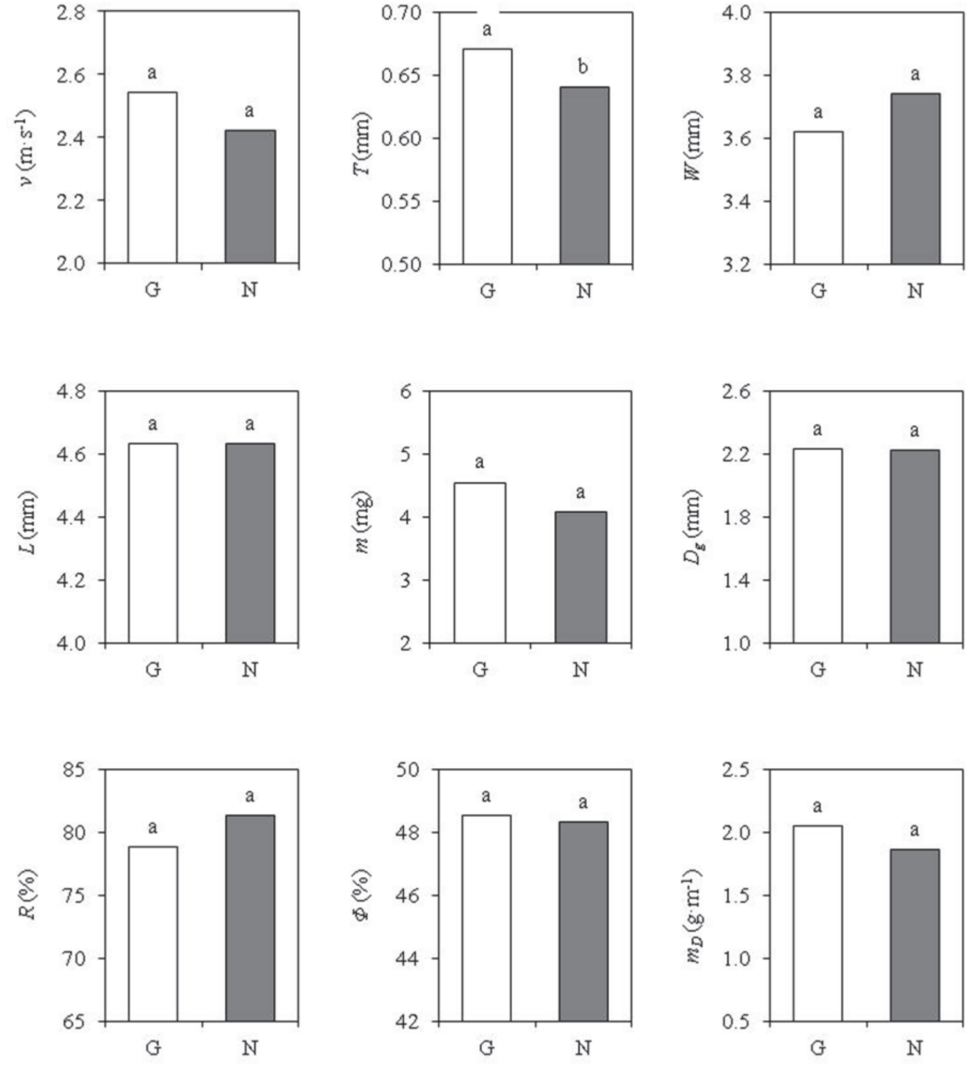

Figure 2. Comparison of significance of differences between physical properties and calculated indices of germinated (G) and non-germinated (N) parsnip seeds: a, b – different letters denote statistically significant differences

The results of a correlation analysis involving physical parameters and the calculated indices of parsnip seeds are presented in Table 2. The critical value of the correlation coefficient was exceeded in only 20 out of 45 comparisons. Seed length was most correlated (6 out of 9 comparisons) and the germination rate index was least correlated (1 out of 9 comparisons) with the remaining parameters. Interestingly, the seed width and seed length were not correlated with seed thickness or seed mass. The above could be attributed to the presence of seed "wings",development of which is probably unrelated to the above parameters. The germination rate index was most highly correlated with seed mass, but the correlation coefficient was not practically significant (> 0.4).

Table 2
Coefficients of Pearson's linear correlation between the physical properties and the calculated indices of parsnip seeds.

Property / index	T	W	L	m	D_g	R	Φ	m_D	W_g
v	**0.513**	-0.132	**-0.199**	**0.588**	0.081	0.077	**0.401**	**0.558**	0.140
T	1	0.147	0.057	**0.231**	**0.546**	0.137	**0.523**	0.062	0.140
W		1	**0.572**	-0.034	**0.818**	**0.507**	0.052	**-0.287**	-0.078
L			1	-0.005	**0.764**	**-0.404**	**-0.656**	**-0.241**	-0.036
m				1	0.081	-0.017	0.124	**0.947**	**0.174**
D_g					1	0.120	-0.033	**-0.227**	0.006
R						1	**0.774**	-0.059	-0.043
Φ							1	0.132	0.063
m_D								1	0.154

Values in bold indicate that the critical value of correlation coefficient were exceeded.

The structure of the germination rate index before and after seed separation into three mass fractions (of almost identical size) is presented in figure 3. The values of the germination rate index indicate that seeds germinated between the 5^{th} and 13^{th} day, and the highest number of seeds sprouted on the 6^{th} day. When seeds were separated based on the mass criterion at the threshold of m=5 mg, the germination capacity of the heavier fraction was estimated at 72%. The heavier fraction contained a high number of early germinating seeds (W_g=0.51-0.60), which substantiates the assumption that germination capacity is correlated with seed mass. The calculated indices demonstrate that the lightest seeds should be separated at the threshold of m=4.8 mg to produce material with 70% germination capacity. In this scenario, approximately 64% of parsnip seeds will be discarded, including 42% of non-germinating seeds and 58% of germinating seeds. The described separation process will result in the loss of 63% of germinating seeds.

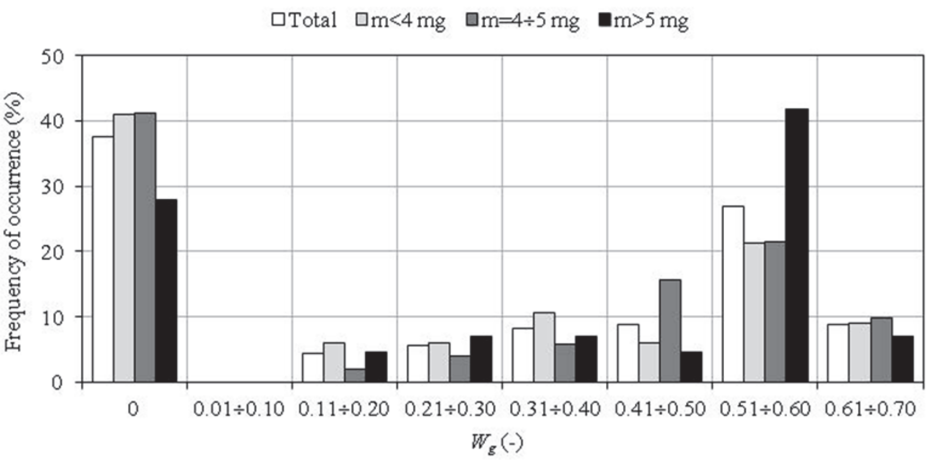

Figure 3. Distribution of germination rate index values of parsnip seeds

Conclusions

1. The physical parameters of parsnip seeds were determined in the following ranges of values: critical transport velocity – 1.38-3.58 m·s^{-1}, thickness – 0.40-1.10 mm, width – 2.45-4.94 mm, length – 3.01-6.22 mm and mass – 0.9-9.0 mg.
2. Germinating seeds were characterized by greater thickness than non-germinating seeds, and the observed differences were statistically significant. The differences in the remaining physical parameters and the calculated indices of germinating and non-germinating were not statistically significant. Non-germinating seeds were characterized by a lower critical transport velocity, mass, sphericity index and specific mass, and greater width and the aspect ratio in comparison with germinating seeds.
3. The germination efficiency of parsnip seeds can be improved through the separation of the lightest seeds. In this study, the achievement of 70% germination capacity resulted in the loss of 63% viable seeds. Such a high loss of germinating seeds does not justify the described separation process. For this reason, other treatment and processing methods should be used to improve the quality of parsnip seeds.

References

Ahirwar, J.R. (2012). Effect of seed size and weight on seed germination of Alangium lamarckii, Akola, India. *Research Journal of Recent Sciences, 1*(ISC-2011), 320-322.

Ahmadi, R.; Kalbasi-Ashtari, A.; Gharibzahedi, S.M.T. (2012). Physical properties of psyllium seed. *International Agrophysics, 26*, 91-93.

Amin, C.; Brinis, L. (2013). Effect of seed size on germination and establishment of vigorous seedlings in durum wheat (Triticum durum Desf.). *Advances in Environmental Biology, 7*(1), 77-81.

Andreoli, C.; Khan, A.A. (2000). Integration of physiological, chemical and biological seed treatments to improve stand establishment and yield of vegetables. *Acta Horticulturae, 533*, 31-38.
Berenbaum, M.R.; Zangerl, A.R. (2006). Parsnip webworms and host plants at home and abroad: trophic complexity in a geographic mosaic. *Ecology, 87*(12), 3070-3081.
Ciupak, A.; Szczurowska, I.; Gładyszewska, B.; Pietruszewski, S. (2007). Impact of laser and magnetic field stimulation on the process of buckwheat seed germination. *Technical Sciences, 10,* 1-10.
Coşkuner, Y.; Karababa, E. (2007). Physical properties of coriander seed (Coriandrum sativum L.). *Journal of Food Engineering, 80*, 408-416.
Domoradzki, M.; Korpal, W. (2009). Analiza kiełkowania nasion otoczkowanych rzodkiewki z zastosowaniem czterech wybranych rodzajów podłoża. *Inżynieria Rolnicza, 2*(111), 27-33.
Domoradzki, M.; Korpal, W.; Weiner, W. (2002). Badania kalibracji nasion warzyw. *Inżynieria Rolnicza, 9*(42), 75-82.
Górnik, K.; Grzesik, M. (1998). Genetyczne, siedliskowe i maternalne uwarunkowania jakości nasion. *Postępy Nauk Rolniczych, 5,* 38-47.
Gruszecki, R. (2013). *Wpływ normy siewu na wielkość i jakość nasion pasternaku*. Annales Universitatis Mariae Curie-Skłodowska Lublin – Polonia, XXIII(1), 18-24.
Grzesik, M.; Janas, R.; Górnik, K.; Romanowska-Duda, Z. (2012). Biologiczne i fizyczne metody stosowane w produkcji i uszlachetnianiu nasion. *Journal of Research and Applications in Agricultural Engineering, 57*(3), 147-152.
Hebda, T.; Micek, P. (2007). Cechy geometryczne ziarna wybranych odmian zbóż. *Inżynieria Rolnicza, 5*(93), 187-193.
Hendrix, S.D. (1984). Variation in Seed Weight and its Effects on Germination in Pastinaca Sativa L. (Umbelliferae). *American Journal of Botany, 71*(6), 795-802.
Hojjat, S.S. (2011). Effects of size on germination and seedling growth of some Lentil genotypes (Lens culinaris Medik.). *International Journal of Agriculture and Crop Sciences, 3*(1), 1-5.
Jamil, Y.; Haq, Z.; Iqbal, M.; Perveen, T.; Amin, N. (2012). Enhancement in growth and yield of mushroom using magnetic field treatment. *International Agrophysics, 26*, 375-380.
Kaliniewicz, Z. (2013). Analysis of frictional properties of cereal seeds. *African Journal of Agricultural Research, 8*(45): 5611-5621.
Kaliniewicz, Z.; Markowski, P.; Anders, A.; Rawa, T.; Liszewski, A.; Fura, S. (2012a). Correlations between the germination capacity and selected attributes of European larch seeds (Larix decidua Mill.). *Technical Sciences, 15*(2), 229-242.
Kaliniewicz, Z.; Markowski, P.; Rawa, T.; Grabowski, A.; Fura, S. (2012b). Współzależność między zdolnością kiełkowania a wybranymi cechami nasion świerka pospolitego (Picea abies). *Inżynieria Przetwórstwa Spożywczego, 1/4*, 13-17.
Kaliniewicz, Z.; Trojanowski, A. (2011). Analiza zmienności i korelacji wybranych cech fizycznych nasion olszy czarnej. *Inżynieria Rolnicza, 8*(133), 167-172.
Kornarzyński, K.; Pietruszewski, S. (2008). Wpływ zmiennego pola magnetycznego na kiełkowanie nasion o niskiej zdolności kiełkowania. *Acta Agrophysica, 11*(2), 429-435.
Krawiec, M.; Dziwulska-Hunek, A.; Kornarzyński, K.; Palonka, S. (2012). Wpływ wybranych czynników fizycznych na kiełkowanie nasion rzodkiewki (Raphanus sativus L.). *Acta Agrophysica, 19*(4), 737-748.
Lynikiene, S.; Pozeliene, A.; Rutkauskas, G. (2006). Influence of corona discharge field on seed viability and dynamics of germination. *International Agrophysics, 20*, 195-200.
Maroufi, K.; Farahani, H.A. (2011). Increasing of Germination by Hydropriming Method in Radish (Raphanus Sativus L.). *Advances in Environmental Biology, 5*(10), 3440-3443.
Martinez-Villaluenga, C.; Peňas, E.; Ciska, E.; Piskula, M.K.; Kozłowska, H.; Vidal-Valverde, C.; Frias, J. (2010). Time dependence of bioactive compounds and antioxidant capacity during germination of different cultivars of broccoli and radish seed. *Food Chemistry, 120*, 710-716.

Matuszkiewicz, W. (2006). *Przewodnik do oznaczania zbiorowisk roślinnych Polski*. PWN, Warszawa, ISBN 83-01-14439-4.

Mohsenin, N.N. (1986). *Physical properties of plant and animal materials*. Gordon and Breach Science Public, New York.

Muszyński, S.; Gładyszewska, B. (2008). Representation of He-Ne laser irradiation effect on radish seeds with selected germination indices. *International Agrophysics, 22,* 151-157.

Mut, Z.; Akay, H. (2010). Effect of seed size and drought stress on germination and seedling growth of naked oat (Avena sativa L.). *Bulgarian Journal of Agricultural Science, 16*(4), 459-467.

Nasiennictwo leśnych drzew i krzewów iglastych. 1995. Red. A. Załęski. Oficyna Edytorska „Wydawnictwo Świat", Warszawa, ISBN 83-85597-27-1.

Nik, M.M.; Babaeian, M.; Tavassol, A. (2011). Effect of seed size and genotype on germination characteristic and seed nutrient content of wheat. *Scientific Research and Essays, 6*(9), 2019-2025.

Norden, N.; Daws, M.I.; Antoine, C.; Gonzalez, M.A.; Garwood, N.C.; Chave, J. (2009). The relationship between seed mass and mean time to germination for 1037 tree species across five tropical forests. *Functional Ecology, 23*(1), 203-210.

Orłowski, M.; Słodkowski, P.; Abramowicz, M. (1993). *Nasiennictwo roślin warzywnych*. Skrypt do ćwiczeń. Wyd. Akademia Rolnicza, Szczecin.

Podleśny, J. (2004). Wpływ stymulacji magnetycznej nasion na wzrost, rozwój i plonowanie roślin uprawnych. *Acta Agrophysica, 4*(2), 459-473.

Polowa uprawa warzyw. 2000. Red. M. Orłowski. Wyd. BRASIKA, Szczecin, ISBN 83-902821-5-1.

Pradhan, R.C.; Meda, V.; Naik, S.N.; Tabil, L. (2010). Physical properties of Canadian grown flaxseed in relation to its processing. *International Journal of Food Properties, 13*, 732-743.

Rabiej, M. (2012). *Statystyka z programem Statistica*. Wyd. Helion, Gliwice, ISBN 978-83-246-4110-9.

Sadeghi, H.; Khazaei, F.; Sheidaei, S.; Yari, L. (2011). Effect of seed size on seed germination behavior of safflower (Carthamus tinctorius L.). *ARPN Journal of Agricultural and Biological Science, 6*(4), 5-8.

Schopfer, P.; Plachy, C.; Frahry, G. (2001). Release of Reactive Oxygen Intermediates (Superoxide Radicals, Hydrogen Peroxide, and Hydroxyl Radicals) and Peroxidase in Germination Radish Seeds Controlled by Light, Gibberellin, and Abscisic Acid. *Plant Physiology, 125*, 1591-1602.

Shankar, U. (2006). Seed size as a predictor of germination success and early seedling growth in 'hollong' (Dipterocarpus macrocarpus Vesque). *New Forests, 31*, 305-320.

Tokarska-Guzik, B.; Dajdok, D.; Zając, M.; Zając, A.; Urbisz, A.; Danielewicz, W. (2012). *Rośliny obcego pochodzenia w Polsce ze szczególnym uwzględnieniem gatunków inwazyjnych*. Wyd. Generalna Dyrekcja Ochrony Środowiska, Warszawa, ISBN 978-83-62940-34-9.

Upadhaya, K.; Pandey, H.N.; Law, P.S. (2007). The Effect of Seed Mass on Germination, Seedling Survival and Growth in Prunus jenkinsii Hook.f. & Thoms. *Turkish Journal of Botany, 31*, 31-36.

Vera, M.L. (1997). Effects of altitude and seed size on germination and seedling survival of heathland plants in north Spain. *Plant Ecology, 133*, 101-106.

Zangerl, A.R.; Stanley, M.C.; Berenbaum, M.R. (2008). Selection for chemical trait remixing in an invasive weed after reassociation with a coevolved specialist. *PNAS, 105*(12), 4547-4552.

WSPÓŁZALEŻNOŚĆ MIĘDZY ZDOLNOŚCIĄ KIEŁKOWANIA A WYBRANYMI CECHAMI NASION PASTERNAKU ZWYCZAJNEGO (*PASTINACA SATIVA L.)*

Streszczenie. Określono prędkość krytyczną unoszenia, podstawowe wymiary (długość, szerokość i grubość) i masę nasion pasternaku zwyczajnego. Na podstawie dokonanych pomiarów obliczono geometryczną średnicę zastępczą, wskaźnik proporcji, wskaźnik sferyczności i masę jednostkową. Następnie przeprowadzono próbę kiełkowania nasion, sprawdzając jej efekty co 12 godzin, a każdemu z nasion przypisano odpowiednią wartość wskaźnika czasu kiełkowania. Porównano ze sobą powyższe cechy i wskaźniki wykorzystując test t dla prób niezależnych i analizę korelacji. Stwierdzono, że skiełkowane i niekiełkujące nasiona różnią się statystycznie istotnie jedynie pod względem swojej grubości. Pewną poprawę zdolności kiełkowania materiału nasiennego można uzyskać przez oddzielanie od niego nasion najlżejszych. W badanym surowcu nasiennym uzyskanie 65% zdolności kiełkowania wiązało się ze stratami nasion prawidłowo wytwarzających kiełki na poziomie ok. 27%.

Słowa kluczowe: pasternak, nasiona, cechy fizyczne, kiełkowanie