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PRIMING OF RED BEET AND SUGAR BEET SEED USING THE INFUSIONS OF CHAMOMILE AND SAGE

Summary

Organic seed to perform well must show high and fast germination. Priming is a popular method of germination course improvement. Combination of priming with herbal treatment can give simultaneously a protection of seeds and seedlings against pathogens. The aim of the study was to determine the usefulness and effectiveness of seeds conditioning with some herbal infusions. The tests were performed in the laboratory and in the growth chamber. In the experiment, the effect of conditioning simultaneously reed beet seed (var. Czerwona Kula) and sugar beet seed (var. Janosik) was examined. Beet seed lots were conditioned in infusions of: chamomile (concentration 30 and 100%), sage (concentration 30% and 100%), and a mixture of chamomile and sage herbal infusions (15% + 15%) and in pure water. Raw and unprimed seeds were the control combination. The study determined: laboratory germination ability, mean time and uniformity of germination, and in the growth chamber: emergence ability, mean time and spread of emergence. The results showed the most effective influence of conditioning in water, 30% infusion of sage and mixed chamomile and sage 15+15%. Chamomile extract had an unfavorable influence, especially on red beet seeds.
***Key words**: chamomile, sage, seed conditioning, germination, uniformity of emergence*

POBUDZANIE NASION BURAKA ĆWIKŁOWEGO I CUKROWEGO W NAPARACH RUMIANKU I SZAŁWII

Streszczenie

Nasiona stosowane w uprawach ekologicznych powinny charakteryzować się wysoką zdolnością kiełkowania i szybkim przebiegiem kiełkowania. Pobudzanie jest popularną metodą, która pozytywnie wpływa na przebieg kiełkowania. Pobudzanie nasion w roztworach ziół może dodatkowo chronić nasiona i siewki z nich wyrosłe przed patogenami. Celem badań było sprawdzenie celowości i efektywności pobudzania nasion w naparach wybranych ziół. Badania przeprowadzono w komorze klimatycznej i w fitotronie. Jednocześnie badano wpływ zabiegów na nasiona buraka ćwikłowego (odm. Czerwona Kula) i buraka cukrowego (odm. Janosik). Partie nasion były pobudzane w naparach rumianku (stężenia 30 i 100%), szałwii (stężenia 30 i 100%) oraz w mieszaninie obu naparów (15% + 15%), a także w wodzie. Kombinację kontrolną stanowiły surowe nasiona, nie poddane zabiegowi pobudzania. W komorze klimatycznej określono: laboratoryjną zdolność kiełkowania oraz średni czas i równomierność kiełkowania nasion, a w fitotronie: zdolność, średni czas i równomierność wschodów. Wyniki wskazują na największą efektywność pobudzania w wodzie, 30% roztworze szałwii oraz mieszaninie rumianku i szałwii 15% + 15%. Napar rumianku miał niekorzystny wpływ na nasion, szczególnie w przypadku buraka cukrowego.
***Słowa kluczowe:** rumianek, szałwia, pobudzanie nasion, kiełkowanie, wschody*

1. Introduction

Sugar beet is the only source of sugar in our climate. It is also a crop of the greatest yielding potential in Poland. Sugar beet roots are very important raw material for food industry and processing. Despite of decrease of acreage in last decade sugar beet production is still an important part of Polish agriculture [15]. Growing interest in organic food results in big demand for organic sugar for food processing. Janosik is a Polish diploid variety from Kutnowska Hodowla Buraka Cukrowego (KHBC), registered in 2009. It gives high field of roots and sugar resistant to rhizomania.

Red beet is a vegetable grown in Poland since 16th century. It is easy to grow, transport and store [5]. Since 2010 the acreage of red beet cultivation grows in Poland, this tendency concerns also organic red beet. Variety Czerwona Kula is commonly cultivated in Poland for many years. Roots are used fresh during the summer and are possible to store and use by food industry [5]. This red beet variety (Czerwona Kula) is also recommended for organic cultivation. Roots of organic red beet contain higher amounts of dry mass, betaine dyes and sugars comparing to the conventional ones [4].

High seed quality is necessary to obtain required yield. Seed dressing and coating with fungicides and insecticides is forbidden in organic farming. Hence the idea of using plant oils, herbal infusions, powders etc. for seed and seedling protection from pathogens. Chamomile and sage are herbs known for they antibacterial and antifungal activity. They are popular in natural medicine and commercially available. Major chemical compounds present within chamomile include apigenin and alpha-bisabolol. Other compounds in chamomile include: sesquiterpenes, terpenoids, flavonoids, coumarins such as herniarin and umbelliferone, phenylpropanoids such as chlorogenic acid and caffeic acid, flavones such as apigenin and luteolin, flavanols such as quercetin and rutin, and polyacetylenes [11, 12, 13]. Sage leaf contains tannic acid, oleic acid, ursonic acid, ursolic acid, carnosol, carnosic acid, fumaric acid, chlorogenic acid, caffeic acid, niacin, nicotinamide, flavones, flavonoid glycosides, and estrogenic substances [2].

Priming is popular sugar beet seed treatment. Seed priming is the process of regulating germination by manag-

ing the temperature and seed moisture content, in order to improve and fasten seed germination. Priming of beet seeds induces increased solubilization of the basic B-subunit of 11-S globulin (a major seed storage protein in sugar beet) [1]. This process has a beneficial effect on the course of germination. Primed seeds are more resistant to unfavorable moisture conditions during the germination than unprimed ones [7].

Considering benefits from process of seed priming and protective action of herbs, an idea of combining these two treatments in one appeared: priming in chamomile and sage infusions.

2. Material and Methods

For testing untreated sugar beet seeds, variety Janosik, derived from the Kutnowska Hodowla Buraka Cukrowego and red beet seeds of variety Czerwona Kula 2 from PNOS in Ożarów Mazowiecki were used. Seeds were then primed in infusions of chamomile, sage and mixture of these herbs. The herbs originated from the company Kawon-Hurt Nowak SP. j. from packages per 50g of chamomile dried flowers (Chamomillae anthodium) and sage leafs (Salviae folium). The infusions were prepared according to the instruction on the label. 50 g of dry herbs were flooded with 1600 ml of boiling water and covered for 15 minutes. Infusions were left to cool.

After straining through a sieve, different combinations of basic infusions were prepared: chamomile 30% concentration (of the basic infusion), chamomile 100% concentration, sage 30% concentration, sage 100% concentration, mixture of sage and chamomile 15% concentration each. Sugar beet and red beet seeds were placed on filter paper and then moistened with 30 ml of every herbal infusion. One seed combination was moistened with distilled water. Boxes containing seeds were kept for 24 h in 21˚C, then seeds were taken out and air dried. Raw, unprimed seeds of sugar beet and red beet were control combination.

In a few days seed were put into germination boxes on a filter paper, moistened with 25 ml of water and placed in a climate chamber at temperature 21˚C. Every seed combination represented 100 seeds in 3 replications. For next 14 days germinating seeds were counted and removed from the boxes. The same seed combinations were sown in the universal soil in 3 replications of 100 seeds. There was the same amount of soil and water in each box. Boxes were placed in phytotron in 15˚C and 50 % humidity. Every day (for 14 days) the number of emerging seedlings was calculated.

On this basis germination ability (%) and plant emergence in phytotron were calculated. Mean time of germination and emergence (Pieper's coefficient) were also counted based on the course of germination (emergence).
Pieper's coefficient was counted by a formula:

$$Pieper's\ coefficient = \frac{\Sigma(d_n \times a_n)}{\Sigma a_n}$$

where:
d_n – number of the day of germination (emergence);
a_n – number of seeds germinated/seedlings emerged on this day [9].

Pieper's coefficient expresses the average number of days from sowing to the moment of germination (or emergence). Low value is connected with fast germination and high seed vigor. The longer time from sowing to germination, the higher is its value [6].

Results were subjected to statistical univariate and two-factor variance analysis with ANOVA program.

3. Results

Generally every method of seed treatment improved seed germination after 4 days in comparison to the untreated control seeds (tab. 1). However sugar beet and red beet reacted differently to the treatment with herbal infusions. In sugar beet a seed priming with water was most effective treatment and in red beet all herbal infusions improved the germination comparing to water priming (fig. 1). Sugar beet seeds germinated much quicker (average 84% germination) than red beet seeds (13%). After 14 days of germination, the differences in germination percentage between sugar beet and red beet were lower and reached 6%, but still were significant (tab. 2). Germination ability of sugar beet seeds was very high and ranged from 99% to 100%. Bigger differences were noted among combinations of red beet seeds (fig. 2). Almost all seed treatments (except of chamomile 30% and 100%) improved red beet seed germination comparing to the untreated control. The highest germination ability was obtained for seeds treated with sage and chamomile mixture (97,8%) and sage in both concentration (96,3% and 95%).

Table 1. Germination ability (%) after 4 days of germination, depending on a type of beet and method of seed treatment

Beet type	Method of seed treatment								
	sage 30%	sage 100%	chamomile 30%	chamomile 100%	sage +chamomile	water	control	mean value	LSD α=0,05
sugar beet	88,7	78,3	85,0	89,0	88,7	95,3	62,0	83,9**	11,14
red beet	15, 7	13,3	14,0	13,7	14,7	11,7	9,7	13,3**	
mean value	52,2**	45,8**	49,5**	51,4**	51,7**	53,5**	52,2**		
LSD α=0,05	7,22								

Source: own work

Table 2. Germination ability (%) after 14 days of germination, depending on a type of beet and method of seed treatment

Beet type	Method of seed treatment								
	sage 30%	sage 100%	chamomile 30%	chamomile 100%	sage + chamomile	water	control	mean value	LSD α=0,05
sugar beet	99,0	100,0	99,0	100,0	100,0	99,3	99,3	99,5**	5,18
red beet	96,3	95,0	89,7	91,7	97,7	94,7	91,0	93,7**	
mean value	97,7**	97,5**	94,4**	95,9**	98,9**	97,0**	95,2**		
LSD α=0,05	3,36								

Source: own work

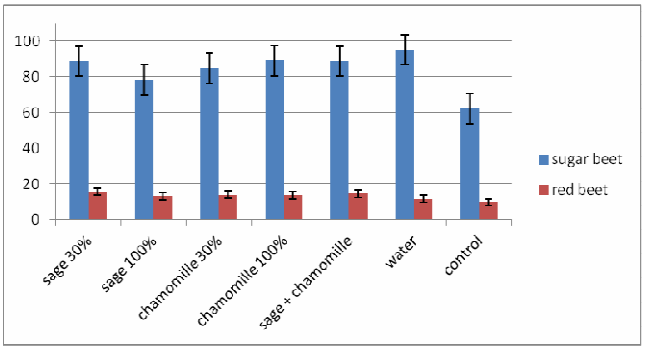

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Fig. 1. Germination ability (%) of sugar beet and red beet seeds after 4 days of germination, depending on a type of beet and method of seed treatment

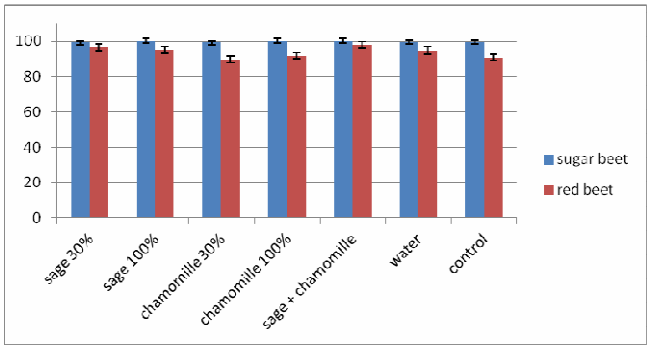

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Fig. 2. Germination ability (%) of sugar beet and red beet seeds after 14 days of germination, depending on a type of beet and method of seed treatment

After 4 days of germination in general all the methods of treatment made average germination time of single seed shorter (tab. 3). But only slight differences among sugar beet seed combinations were visible (fig. 3). Germination time of seeds primed in water was the shortest – 0,16 day shorter comparing to the unprimed control seeds. In red beet also all treated seeds germinated faster than untreated ones, but an addition of herbal infusions made the germination quicker in comparison to seeds primed in pure water.

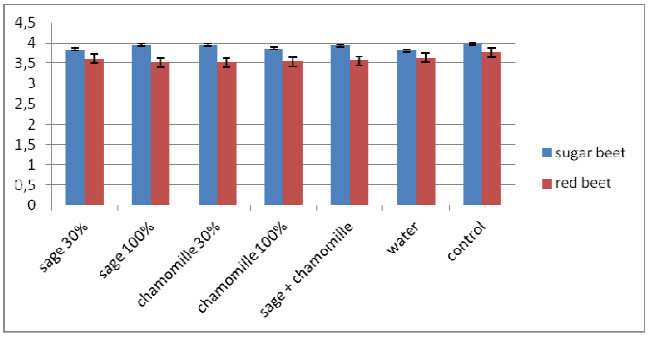

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Fig. 3. Germination speed (Pieper's Coefficient – days) after 4 days of germination of sugar beet and red beet seeds, depending on a type of beet and method of seed treatment

All the treatments caused a decrease in germination time after 14 days for both beet types (tab. 4). In case of sugar beet priming in water and in sage infusion (30% solution) (fig. 4) were the most effective treatments. Red beet seeds treated with water and with sage infusion (both concentrations) germinated more than 0,4 day faster than control ones.

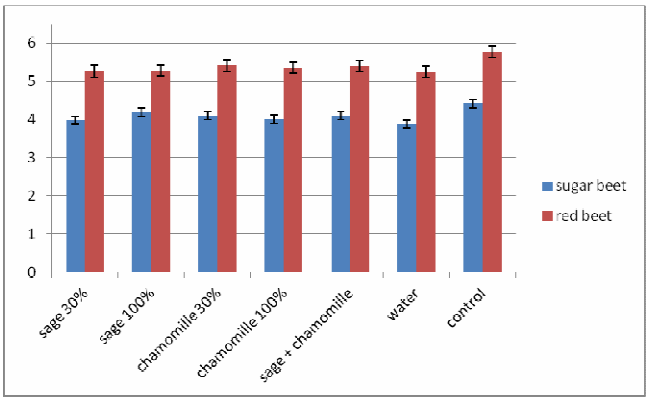

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Fig. 4. Germination speed (Pieper's Coefficient – days) after 14 days of germination of sugar beet and red beet seeds, depending on a type of beet and method of seed treatment

Table 3. Germination speed (Pieper's Coefficient – days) after 4 days of germination, depending on a type of beet and method of seed treatment

Beet type	Method of seed treatment								
	sage 30%	sage 100%	chamomile 30%	chamomile 100%	sage + chamomile	water	control	mean value	LSD α=0,05
sugar beet	3,85	3,95	3,95	3,87	3,94	3,82	3,98	3,91**	0,16
red beet	3,61	3,51	3,52	3,54	3,55	3,63	3,77	3,59**	
mean value	3,73**	3,73**	3,74**	3,71**	3,75**	3,73**	3,88**		
LSD α=0,05	0,10								

Source: own work

Table 4. Germination speed (Pieper's Coefficient – days) after 14 days of germination, depending on a type of beet and method of seed treatment

Beet type	Method of seed treatment								
	sage 30%	sage 100%	chamomile 30%	chamomile 100%	sage + chamomile	water	control	mean value	LSD α=0,05
sugar beet	3,98	4,19	4,10	4,01	4,10	3,87	4,41	4,09**	0,23
red beet	5,26	5,27	5,41	5,35	5,40	5,24	5,77	5,39**	
mean value	4,62**	4,73**	4,76**	4,68**	4,75**	4,56**	5,09**		
LSD α=0,05	0,15								

Source: own work

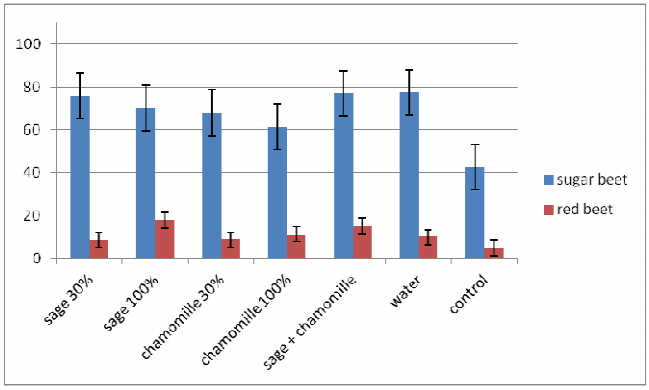
Table 5. Plant emergence (%) in climate chamber after 6 days from sowing, depending on a type of beet and method of seed treatment

Beet type	Method of seed treatment								
	sage 30%	sage 100%	chamomile 30%	chamomile 100%	sage + chamomile	water	control	mean value	LSD α=0,05
sugar beet	75,7	70,3	68,0	61,3	77,0	77,3	42,7	67,5**	16,38
red beet	8,7	18,0	9,0	11,4	15,3	10,0	5,0	11,1**	
mean value	42,2**	44,2**	38,5**	36,4**	46,2**	43,7**	23,9**		
LSD α=0,05	10,61								

Source: own work

Method of seed treatment did not influence uniformity of seed germination after 4 and 14 days of germination. There was only an effect of beet type visible. Therefore these results are not presented in the paper.

Plant emergence of both beet types after 6 days from sowing differed significantly (tab. 5). In the soil in climate chamber plant emergence for sugar beet reached more than 67% and for red beet 11% only. It is still visible that all the treatments improved plant emergence. As it was shown before, treatment with pure water is the most effective for sugar beet and for red beet usually an addition of herbs is an advantage, but the benefit depends on a kind of herbal infusion and it's concentration (fig. 5).



Source: own work

Fig. 5. Plant emergence (%) of sugar beet and red beet after 6 days from sowing, depending on a type of beet and method of seed treatment

Speed and uniformity of plant emergence showed differences in relation only to the beet type, not to the method of seed treatment, so the results are not presented in this paper. There was no possibility to determine plant emergence after a longer time from sowing because of high differences in rate of emergence between 2 types of beet and multigermity of red beet sowing material.

4. Discussion

An assortment of products that can be used for seed treatment in organic farming is very limited, due to the strict law. Due to the ongoing development of organic farming in Poland, a number of studies on methods of seed quality improvement and plant protection against pathogens is carried out. Effects of natural plant substances used for seed treatment is still a current and investigated topic [3, 8, 10]. The method presented in this paper is a combination of seed conditioning and dressing with the plant active ingredients, but the effect of potential plant protection was not examined in this experiment. The object of the experiment was to determine if there is the effect of stimulation of seed germination with natural substances present in sage and chamomile infusions.

The results show much better quality of sugar beet sowing material comparing to red beet seeds. It results from the genetic traits and place of reproduction of seeds and is related to the differences in sowing technology. Sugar beet seeds are produced for industrial big farms, they are reproduced in the countries with suitable, warm climate [14]. Especially long and sunny summer is crucial. An improvement of seeds quality is also one of the traits selected in breeding program. High field emergence is so important because they are sown with sowing drills, and their spacing is not changed. Red beet – one of basic organic vegetables is usually grown on smaller areas, even backyard gardens. Seeds are usually reproduced in Poland and there is not much emphasis on their quality. They are usually sown in rows and after plant emergence – thinned to a suitable spacing.

Seeds of both types of beets showed a positive reaction to all used methods of treatment. But these reactions differed in details. In sugar beet priming with water was the most effective treatment. This method, but also conditioning with herbal infusions, allowed to raise germination ability and speed after 4 days. After 14 days of germination all seed combinations germinated in almost 100%, but the differences in germination speed were still significant. Sugar beet plant emergence in soil was higher from treated comparing to non-treated seeds, but in case of 100% chamomile infusion the difference was not significant. Possibility of use of herbal infusions to protect sugar beet seeds is interesting in the context of further protection of seedlings and young plants against pathogens.

In case of red beet seeds addition of herbal infusions made process of seed conditioning more efficient. These seeds showed higher germination ability after 4 days, but after the longer time germination of seeds treated with chamomile (both concentration) and pure water was similar to control ones. Only combinations of seeds treated with sage showed an improvement of germination. There were no significant differences in germination speed after 4 days, but after 14 days seeds conditioned in water or in sage infusions (both concentrations) germinated faster than control ones. Plant emergence 6 days after sowing was quite low, but seeds treated with 100% infusion of sage and mixture of sage and chamomile gave higher number of seedlings than control seeds and other combinations.

5. Conclusions

1. Both types of beets show different reactions to the conditioning in herbal infusions.
2. Sugar beet reacts positively to seed conditioning. Addition of herbal infusions to the water slightly decreased germination speed.

3. Conditioning of red beet seeds is more effective in infusions containing sage or mixture of sage and chamomile.
4. Chamomile, especially in higher concentrations can be toxic for red beet and sugar beet seeds.

6. References

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