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Use of electroseparator in improving the quality of ecological buckwheat seeds

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Fighting weeds on an ecological farm is only possible by crop manual or mechanical weeding, therefore. Buckwheat seed growers have a lot of problems with seed cleaning from weed seeds similar in size. The article presents a comparison of the quality of buckwheat seeds grown on farms of ecological and traditional production. The cleanliness and germination of seeds from ecological farms were found to be significantly lower than from traditional farms. The results of cleaning buckwheat seeds (*Fagopyrum esculentum*) by an electroseparator are presented. It was possible to obtain 60% of seeds corresponding to C1 and C2 category requirements from seeds grown on an ecological farm and rated ill-conditioned due to high contamination and low germination. The increase of ecological seed germination (by 12%) after special cleaning was significant. Seed economic value increased on average by 13% and the seeds germinated practically simultaneously. The use of electro-separator for cleaning conditional seeds allowed obtaining 40% of seeds corresponding to B and 38% to C1 and C2 category requirements. Seed economic value was by 11% higher compared with control seeds. A conveyor type separator with a flannel belt operating in the high voltage field was used for special seed cleaning. The voltage of the electrostatic and corona discharge field was 40 kV.

Key words: buckwheat seeds, ecological and traditional farming, cleanliness, germination, electro-separator

INTRODUCTION

Ecological farms have to follow the European Union Regulation No 2092-91/EEC (Valstybės žinios, 2002), one of its paragraphs requiring the use of only ecological seeds. The production cost of seed material is increased by many additional technological stages, e. g., weeding of seed areas, trying to fight weeds with hard-to-detach seeds, distribution of seeding material into fractions by sifting off seeds smaller than 2.5 mm. The value of quality seeds in ecological agriculture is much more important than in intensive agriculture because plant protection is weaker on ecological farms.

Buckwheat (*Fagopyrum esculentum*) growers on ecological farms face the seed cleaning–sorting problem. After the initial and even after the main cleaning, there still are seeds of the weeds hard to clean left, such as wild radish (*Raphanus raphanistrum* L.), field bindweed (*Convolvulus arvensis* L.) and other seeds similar to buckwheat seeds in their dimensions. The minimum requirements for buckwheat seeds of category B allow 5 units of wild radish and 15 units of other weeds (Valstybės žinios, 2000). The same requirements for seeds of categories C1 and C2 allow 35 units of wild radish and 80 units of other weeds.

The main separation was carried out after previous separation with the help of air flow and sieves. For this purpose expensive and complicated machinery was used (Strakšas, 1994). All these machines are able to separate seeds according to their size, i. e. width, length and thickness (Rawa, Kaliniewicz, 1998; Nurrilin, 2006). When the number of defective seeds and premixes is rather high and their thickness varies greatly, the buckwheat should be cleaned on a pneumatic separation table with a special installation for the differential air flow distribution (Drintcha, Pavlov, 2002) or in a photoelectric separator (Choszez et al., 2003).

Separators operating by way of superposition between the forces of different physical nature could be used on ecological farms to sort and clean buckwheat seeds. Seeds are distinguished by the totality of mechanical and electrical features, which enables the separation of biologically valuable seeds (Podobiedov, Tarushkin, 2000; Yadov, 2000; Pozeliene, Lynikienė, 2009).

The procedures of the main, special separation and sorting should be fulfilled after the termination of seed maturation simultaneously with seed preparation before sowing (Romanovska, Ražukas, 2006). Seed processing before sowing employs numerous physical actions of electromagnetic nature (Rybinski, Garczyski, 2004; Palov, Sirakov, 2004; Martinez et al., 2009; Lynikiene, Pozeliene, Rutkauskas, 2006). The use of electric field is most expedient from the point of view of technology, versatility, and energy saving (Požėlienė, Lynikienė, Rutkauskas, 2007; Bobryshev, Starodubtseva, Popov, 2000).

The aim of the present study was, employing a high-voltage electric field, to analyse the cleaning possibilities of buckwheat seeds grown on an ecological farm, and to establish the quality indicators of sorted seeds.

METHODS

In 2007–2008, buckwheat seeds from three ecological and three traditional farms, cleaned with traditional cleaning machines were used for the estimation of their quality. After that, buckwheat seeds from one ecological and one traditional farm were cleaned with a conveyer-type electro-separator (Požėlienė, Lynikienė, 2009).

The seeds get charge from the potential corona discharge electrode in the horizontal part of the grounded conveyer belt. The seeds separate from the belt in its cylindrical part and enter the fractions of the reception sizer according to their mass and change.

The quality of seeds grown on ecological and traditional farms and cleaned with an electroseparator was tested according to the LST1402-2:1995 standard in three replicates. By cleaning seeds with an electroseparator, the following characteristics were established: seed output into the electroseparator's fractions; 1000 seed mass, germination, cleanliness, and the amount of impurities in control and separate fraction seeds. According to the standard, 1000 seed mass is established from two samples 500 seeds each by recalculating the weight for 1000 seeds and calculating the average; seed cleanliness is established from two weighings 50 g each, and impurities, calculated in units, are weighed as well. The seeds cleaned with an electroseparator were seeded 7 days after the action. The seeds were germinated on moist filtration paper in Petri dishes put into a thermostat at a temperature of 20 °C. Each variant was germinated in four replicates of 100 seeds. Upon calculating germination and cleanliness, seed economic value (V) is calculated in percentage:

$$V = c\,g\,/\,100, \qquad (1)$$

where c is seed cleanliness, %, and g is seed germination, %.

When establishing seed germination dynamics, control seeds and those taken from electro-separator fractions are sown on the same day, and the number of germinated seeds in all variants is counted every day during a seven-day period. Student's t-test was used to evaluate the mean germination values of control seeds and those treated with the electric field (Kruopis, 1993).

RESULTS

The quality of seeds grown on ecological and traditional farms is shown in Table 1.

The results revealed that the content of wild radish seeds in buckwheat seeds grown on ecological farms exceeded the mandatory requirements for buckwheat seed quality 10 times. The cleanliness and germination of seeds from an ecological farm were significantly lower than from traditional farms. The difference between seed mass in both farms was insignificant. Seeds from the ecological and the traditional farms were cleaned with an electroseparator. On the basis of the previous investigations (Požėlienė, Lynikienė, Šapailaitė, 2007), a flannel conveyor belt was chosen; its movement speed was 0.24 m s^{-1}. The voltage of the electric field was 40 kV. The results of seed cleaning by electro-separator are given in Table 2.

Ecological seeds of electroseparator fractions I and II, which met the requirements for categories C1 and C2 according to all indicators, were sown. The results have shown that from ill-conditioned seeds it is possible to obtain 60% of seeds meeting category requirements. The germination and mass of those seeds are higher than the control indicators. The economic value of seeds for sowing, cleaned with electroseparator, was by 13% higher compared with the control. When an electroseparator was used for

Table 1. **Quality of seeds grown on ecological and traditional farms**

Farm	$\bar{x}$	s	$t_{calc.}$	Comment
Seed cleanliness, %				
Ecological	97.62	0.16		
Traditional	99.43	0.36	9.12	Significant difference
Seed germination, %				
Ecological	73.5	3.51		
Traditional	82.5	4.43	3.18	Significant difference
1000 seed mass, g				
Ecological	25.28	1.45		
Traditional	26.0	0.41	0.96	Insignificant difference
Impurities, unit/1000 g total of other plant species				
Ecological	522	50.52		
Traditional	70	12.5	17.37	Significant difference
Cultivated plants				
Ecological	51.0	6.63		
Traditional	15.0	4.4	9.05	Significant difference
Weeds				
Ecological	75.5	13.6		
Traditional	45.0	13.2	3.22	Significant difference
Wild radish				
Ecological	395.5	41.19		
Traditional	10.0	1.73	9.56	Significant difference
$f = 6$, $p = 0.05$, $t_{(0.05.6)} = 2.45$				

Note: f – number of respective degrees of freedom; p – probability level; $\bar{x}$ – arithmetic mean of germination; s – estimated standard deviation; $t_{calc.}$ – calculated and $t_{(0.05;\,6)}$ – Student's t-test from the tables.

Table 2. **Results of seed cleaning with electroseparator**

Variant	Fraction	Indicators				Impurities, unit / 1000 g				Meeting category	Economic value
		Output, %	Seed cleanliness, %	Seed germination, %	1000 seed mass g	Total of other plant species	of which: cultivated plants	Weeds	Wild radish		
Control (ecological farm)	K	100	97.7	71	25.9	524	42	42	440	Fails short	69.4
Electroseparator $U = 40$ kV, $v = 0.24$ m s^{-1}	I	25	99.2	84	28.2	20	5	–	15	C1 and C2	83.3
	II	38	99.0	83	27.1	35	5	–	30	C1 and C2	82.2
	III	23	97.9	79	25.0	946	60	86	200	Fails short	77.3
	IV	14	91.2	64	20.0	2056	178	158	1720	Fails short	58.4
Control (traditional farm)	K	100	99.2	82.0	27.13	94	15	50	29	C1 and C2	81.3
Electroseparator $U = 40$ kV, $v = 0.24$ m s^{-1}	I–II	40	99.6	93.0	29.13	14	2	12	0	B	92.6
	III	38	99.3	92.5	27.19	85	10	55	20	C1 and C2	91.8
	IV	22	98.3	85.85	23.38	255	47	110	98	Fails short	84.3

cleaning seeds froms traditional farms, about 80% of seeds corresponded to the requirements. Half of seeds had the category higher than in the control. The germination, mass and economic value of those seeds was higher than control indicators.

Assessment of germination of the control seeds and seeds in electroseparator fractions at the reliability p = 0.05, applying Student's t-test, is shown in Table 3.

The assessment of germination shows that biologically inferior seeds of particularly low germination pass into fraction IV; this is also proved by their 1000 seed mass which is lower than the control one. The germination dynamics of control ecological seeds and seeds of different fractions is shown in Figure. The diagram of seed germination dynamics shows that seeds cleaned with an electroseparator, no matter to which fraction they passed, germinate at the same

Table 3. **Assessment of differences in buckwheat seed germinations**

	$\bar{x}$	s	$t_{calc.}$	Note
Control (ecological farm)	71 ± 4.4	4.08		
I	84 ± 2.8	2.31	5.55	Significant increase
II	83 ± 2.3	1.83	5.38	Significant increase
III	79 ± 1.7	1.41	3.71	Significant increase
IV	64 ± 3.9	3.16	2.71	Significant decrease
Control (traditional farm)	84 ± 4.6	3.21		
I–II	93 ± 2.5	2.0	4.6	Significant increase
III	92.5 ± 1.6	1.29	4.8	Significant increase
IV	85.8 ± 6.8	5.56	0.45	Non-significant increase
		$t_{(0.05, 6)} = 2.45$		

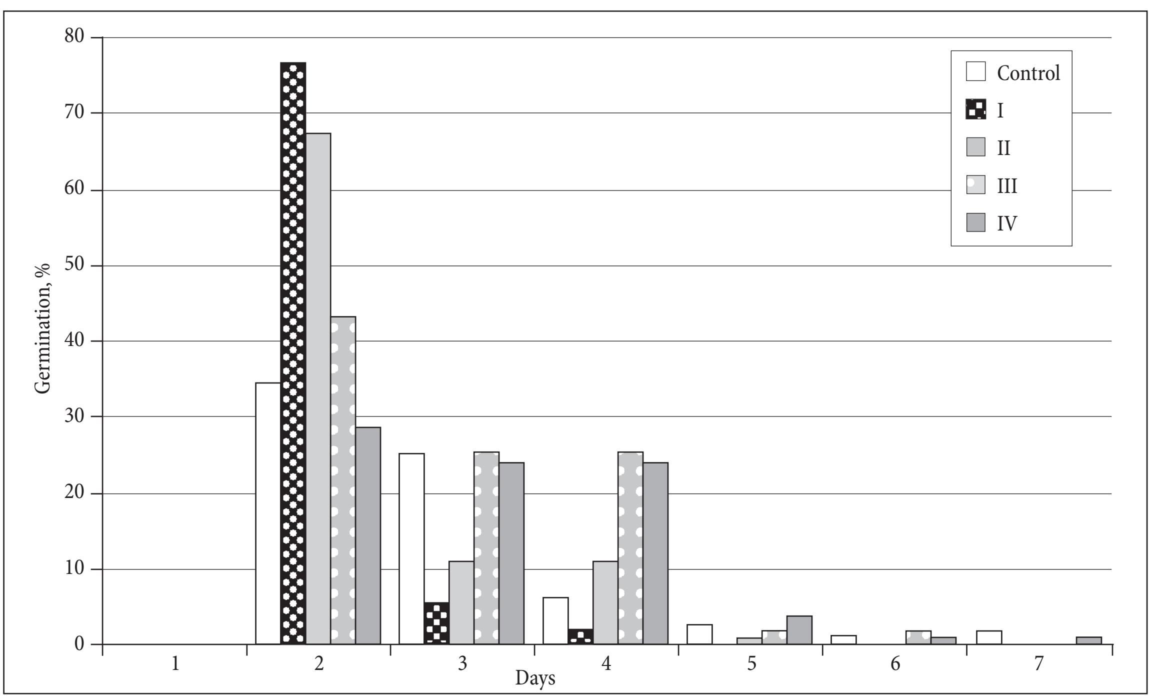

Figure. Seed germination dynamics

time (on the second day after sowing). The sprouting of the control and fraction IV seeds from an ecological farm lasts during the whole period of germination.

CONCLUSIONS

1. The content of wild radish seeds in buckwheat seeds grown on ecological farms exceeded the requirements for seed quality 5 times.

2. The use of electroseparator for cleaning special ecological buckwheat seeds allows obtaining 60% of seeds corresponding to C1 and C2 category requirements. The economic value of these seeds was by 13% higher compared with the value of the control seeds.

3. The use of electroseparator for cleaning conditioned seeds allows obtaining 40% of seeds corresponding to B and 38% to C1 and C2 category requirements. Seed economic value is by 11% higher compared with the value of control seeds.

4. The application of electric field allows seed sorting by biological value and stimulates their germination.

5. The increase of germination of seeds for sowing (by 12%) is significant, and they germinate simultaneously.

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ELEKTROSEPARATORIAUS PANAUDOJIMAS GERINANT EKOLOGIŠKŲ GRIKIŲ SĖKLŲ KOKYBĘ

Santrauka

Ekologiniame ūkyje pasėlius galima tik ravėti, todėl grikių sėklos augintojams itin sudėtinga sėklas valyti nuo panašių matmenų piktžolių sėklų. Straipsnyje palyginta ekologiniuose ir tradicinio ūkininkavimo ūkiuose išaugintų grikių sėklų kokybė. Nustatyta, kad ekologiniame ūkyje išaugintų sėklų švarumas ir daigumas yra patikimai mažesnis nei tradicinio ūkininkavimo ūkiuose. Pateikti ekologiniame ūkyje išaugintų grikių (*Fagopyrum esculentum*) sėklų specialaus valymo elektroseparatoriumi rezultatai. Tyrimais nustatyta, kad iš ekologiniame ūkyje išaugintos ir dėl didelio užterštumo bei mažo daigumo nekondicinės sėklos, galima gauti 60 % sėklos, atitinkančios C1 ir C2 kategorijos reikalavimus. Po specialaus valymo sėjai skirtos sėklos daigumo padidėjimas 12 % yra patikimas. Sėklos ūkinė vertė padidėja vidutiniškai 11 % ir sėklos praktiškai sudygsta vienu metu. Specialiai sėklos valomos transporteriniu separatoriumi su flaneline juosta. Elektrostatinio ir vainikinio išlydžio lauko įtampa yra 40 kV.

Raktažodžiai: grikių sėkla, ekologinis ir tradicinis ūkis, švarumas, daigumas, elektroseparatorius