Scientific quarterly journal e-ISNN 2449-5999

Agricultural Engineering

2015: 1(153):35-45

Homepage: http://ir.ptir.org

DOI: http://dx.medra.org/10.14654/ir.2015.153.104

A MODERN METHOD OF OBTAINING ORGANIC SEEDS OF ONION AND RADISH

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ARTICLE INFO

Article history:
Received: November 2014
Received in the revised form:
January 2015
Accepted: February 2015

Keywords:
organic seeds
seed technology
radish seed
onion seed

ABSTRACT

The paper presents the results of obtaining radish and onion seed on an organic farm and the results of processing seeds after harvesting. The proposed technology of seeds preparation for sowing involves processes of hydraulic separation, washing and leaching, drying, calibration, inoculation and coating. Plants were protected with preparations authorized for organic farming. Obtained organic seed material is consistent with current quality requirements.

Introduction

European Union, which prefers forms of sustainable development of food production, puts pressure on a traditional form of farming in rural areas, funding research and subsidizing production of organic food. Organic food is produced in organic farms with natural methods without the use of chemical crop protection substances and fertilizers. Protection of plantation consists in the use of crop rotation and physical and mechanical methods of crop protection. As a result of such approach to agricultural production, we protect environment and ensure maintenance of correct soil structure and fertility.

Green fertilizers, compost, manure and liming are used in fertilization. The remaining requirements have been included in the Regulation of the Council of Ministers of the European Community no. 834/2007. Crop protection chemicals are virtually banned, except for some natural preparations.

Seeds for organic production must come from organic seed plantations. Thus seed cultivation in chemically unprotected farms is necessary.

Vegetable seeds from commodity plantations must meet requirements for the seed material. This postulate is executed with a method of seed treatment with crop protection chemicals. A current technology of seed extraction comes down to several preventive sprayings of a seed plantation with seed plants crop protection substances, mechanical harvesting of seeds, cleaning of contaminations through sifting and winnowing.

Obtaining seeds from an organic plantation without the use of chemicals is impossible with this method. Two issues need to be solved; the first one concerns preparation of seeds for sowing in order to obtain healthy plants; the second problem relates to decontamination and purifying of the seed crop. The basis for ensuring a high quality of vegetables, which come from organic crops, are healthy seeds with high germination ability.

A need to develop procedures and new technologies for both harvesting as well as preparation of seeds for sowing in organic farms emerged. The state controls the production and economic turnover of organic products. (Act on Organic Agriculture Journal of Laws 116, item 975 as of 26th June 2009, as amended, Journal of Laws, item 55 as of 25th December 2014).

For particular varieties of vegetables, methods of seeds preparation for sowing and after-harvest procedure of seeds processing in order to obtain a high quality of the sowing material should be developed (Domoradzki et al., 2004). Such proceedings as a result come down to developing new operations carried out on seeds and construction of appropriate devices for this purpose (Domoradzki, 2005). These processes are investigated in many countries (Khan, 1992; Parera et al., 1995) and funded in the EU countries.

The objective of the paper

The objective of the paper was to develop procedures for preparing seeds for sowing for an organic plantation and developing an after-harvest organic seeds processing: in case of radish – a one-year plant and in case of onion – a two-year old plant.

For development of procedures and new production methods, the following post-harvest processes of radish and onion seeds processing, which were described by (Domoradzki and Dzieniecki, 2008; Domoradzki, 2011) were selected:

- Classic initial cleaning on screens with windowing of contaminations.
- Hydrostatic separation for onion seeds, which allows removal of a part of a perianth and stems, which contaminate seeds.
- The process of cleaning seeds with water aims at the removal of mineral, microbiological and flotaing contaminations.
- Fast drying after wet operations in order to prevent initialization of germination processes in seeds.
- Seeds calibration on screens in order to select a fraction of the best germinating seeds.

From the pre-sowing seeds processing, a decision was taken to:

- Treat seeds with organic dressings which can be used in organic agriculture.
- Seeds inoculation with fungal spores *Polyversum* and *Trichoderme viryde*
- Seeds coating with peat and mineral materials in order to protect seeds against the attack of pathogens which live in soil, ensuring proper conditions during germination.

The presented proposal of technology aims at obtaining sowing material from organic plantations with quality compliant to seed standards and is subject to experimental verification.

Materials and methods

Radish seeds of Lucynka variety and common onion of Supra variety were used for research. Seeds for sowing on a plantation in an organic farm were prepared by sowing basic seeds from cultivation stations obtained through PNOS [Polish Seed Production, Horticulture and Nursery], in Ożarów Mazowiecki. Seeds for sowing were treated with 1% chitosan relatively to the seeds mass and inoculated with fungal spores in the amount of 10 items per one seed ($1 \cdot 10^6$ CFU$\cdot g^{-1}$) and coated. Detailed methods of seed inoculation and coating were discussed in the paper (Domoradzki, 2011). Plants on the field were protected with Biseptol sprayings.

Experiments were carried out on production fields of organic farms in Kiełpin, Kujawsko-Pomorskie Voivodeship. Experimental cultivations were set on soils belonging to IIIa and IIIb soil classification. Soil reaction was respectfully pH=7.0 and pH=6.6. Low precipitations within 450 mm-550 mm/year, periodical water deficiencies are characteristic for this land. Therefore, sprinkling of experimental fields was maintained. Experimental fields with the area of 200 m^2 were limed and fertilized with a compost

Preparation of seeds for sowing

Initial coating

A layer of peat in the amount of 70 g per 100 g of seeds within 4 hours was placed on seeds in a granulation plate with the use of a 5% dextrin solution (Domoradzki, 2008a). Seeds after coating were dried in a chamber drier with a reversed flow of air (from the top to the bottom) with a maximum temperature of 35ºC. (Domoradzki, 2006)

Seeds coating with fungal spores

Seeds after drying were moistened with water solution of 5% dextrin or 2% polyvinyl alcohol and the peat layer was placed in a granulation plate . The layer was composed of 20 g of peat with fungal spores *Polyversum* and *Trichoderme viride* in the amount of 10 items per one seed. Concentration of spores approximately $1 \cdot 10^6$ cfu$\cdot g^{-1}$. A layer of the dolomite and clay mixture was placed. Seeds after treatment within 4 hours were dried with air in the temperature of 25ºC.

Pot experiments

Numerous experiments, which were to determine the impact of seeds preparation on their germination and growth as well as seedlings health, were carried out. The tests were performed in the climatic chamber of the Department of Phytopathology of the University of Technology and Life Sciences in Bydgoszcz. Experiments were carried out in 5 repeats and one repeat consisted in a pot with 20 seeds. Material for pots consisted in soil from the field in Kiełpin.

Lucynka radish

Table 1
Number and height of radish seedlings in a pot experiment

Facility	1st term of observation			2nd term of observation		
	Average height (mm)	Germination		Average height (mm)	Germination	
		Number of seedlings	(%) for control		Number of seedlings	(%) for control
Control	7.4	84	100.0 a	8.6	94	100.0 a
Polyversum + coat	5.2	46	54.8 b	7.1	61	64.9 b
T. viride + coat	6.4	52	61.9 b	8.1	67	71.3 b
Chitozan + coat	8.3	48	57.1 b	9.7	61	64.9 b
T. viride + chitosan + coat	7.2	50	59.2 b	9.0	64	68.1 b

* the same letters in a column stand for values which do not differ significantly (α=0.05)

Despite generally small differences between particular manners of seeds preparation, a positive impact of 1% chitosan additive on the seeds mass, on an average height of seedlings should be emphasised (table 2). The impact of *Trichoderma viride* on the seedling germination was investigated.

Table 2
Impact of treatment of radish seedlings with preparation which contains gonidia Trichoderma viride and the composition of coat on germinations in the pot experiment

Facility**	Capsule	Number of days after starting the experiment				
		5	6	8	10	13
		Percentage of germinations				
Control	-	72.0 a	77.0 a	80.0 a	80.0 a	80.0 a
Trichoderma viride	-	40.0 b	57.0 ab	65.0 ab	62.0 a	70.0 a
Dust, DX, *Trichoderma viride*	+	3.0 c	30.0 c	50,0 b	60.0 a	65.0 a
Dust, DX, Torf, *Trichoderma viride*	+	45,0 b	62.0 ab	72,0 ab	77.0 a	77.0 a
Dust, APV, *Trichoderma viride*	+	12.0 c	40.0 bc	52.0 b	62.0 a	62.0 a
Dust, APV, Torf, *Trichoderma viride*	+	50.0 ab	67.0 a	82.0 a	82.0 a	85.0 a

* the same letters in a column stand for values which do not differ significantly (α=0.05)
** Dust (peat, dolomite and clay) DX (yellop dextrin), APV (polivynyl alcohol) (+) coated seeds, (-) non-coated seeds

Based on the analysis of results it may be stated that the best results were obtained for the last combination in a table, where in the composition of coat peat and polyvinyl alcohol

were used. It is confirmed by the tests on the healthiness of radish seedlings presented in table 3.

Table 3
Impact of treatment of radish seedlings with preparation which contains conidia Trichoderma viride and the composition of coat on germinations in the pot experiment

Facility*	Capsule	Number of germinations of seedlings for 100 seeds	(%) of affected seedlings	IR [fungi infestation ratio of seedlings] W (%)	CFU** on a seed (in a capsule)
Control	-	80	6.2	2.7	-
Trichoderma viride	-	70	7.1	3.4	12.4
Dust, DX, *Trichoderma viride*	+	65	0.0	0.0	24.7
Dust, DX, Muskeg, *Trichoderma viride*	+	77	3.8	1.6	7.9
Dust, APV, *Trichoderma viride*	+	62	4.0	2.2	34.0

* Dust (muskeg, dolomite and clay) DX (yellop dextrin), APV (polivynyl alcohol) (+) coated seeds, (-) non-coated seeds
** CFU – colony forming units

The tests on the impact of the washout treatment on the number of germinations of radish seedlings and their healthiness did not prove any significant differences.

Onion

Table 4 presents the research results on the impact of the washing treatment and onion seeds treatment with a preparation which includes conidia *Trichoderma viride*.

Table 4
The impact of washing and treating onion seeds with preparation which includes conidia Trichoderma viride on the number of seedlings germinations in the pot experiment

Facility	Number of seedlings germinations, (%)	CFU on a seed (in a coat)
Control	93 a	-
Washed	85 ab	-
Washed +coat	77 b	-
Washed, treated *Trichoderma viride* (without a coat)	72 bc	142.9
Washed, treated *Trichoderma viride* + coat	62 c	34.0
Washed, treated *Trichoderma v* + coat+suspension**	58 c	161.9

* values in a column marked with the same letters do not differ significantly (at α=0.05)
** 1% solution of preparation with spores in water

Expected positive impact of the developed combination of onion seeds, including washing treatment on the number of seedlings germinations did not give a higher result than the control sample (table 4).

Field research

Lucynka radish

Experiments on the possibility of obtaining radish seeds in an organic system were carried out in a certified organic farm Kiełpin in a three-year period; they consisted in 5 repeats for 5 combinations. Observations of the growth of plants in a germination stage proved that they were uneven.

Table 5
Germinations of radish seedlings in an organic farm

Facility	% of germinations in relation to control
Control	100.0 a
Chitosan+coat	82.5 b
Chitosan+*T. viride*+coat	77.2 b
T. viride+coat	79.5 b
Polyversum+coat	76.0 b

* the same letters in a column stand for values which do not differ significantly (α=0.05)

Between germination of the coated seeds there were no significant differences during germination. Phytopathologic analysis proved that seedlings from all combinations characterized with good health. Only single plants had symptoms of blights. Plants were developing well. They had favourable weather conditions. Due to a relatively dry and warm vegetation season, diseases did not occur often. The main problem in radish cultivation for seeds constituted pests, which fed before and during flowering.

Based on two-year experiments, it should be stated that radish cultivation for seeds in the organic system, with no zoocide protection is low effective. Collecting insects to traps and using net tunnels is a solution.

Supra onion

Plants in a vegetation period were healthy, regardless the applied biopreparations. In the end of vegetation, pseudo mildew occurred (*Peronospora destructor*). Its intensity was not significant and the applied treatments did not influenced the plants health (table 7).

Plants germinations were at the same level, regardless the applied combinations and were from 58.8 to 63.2%.

Table 6
Germinations and average mass of onion seedlings in the field experiment

Facility (coat)	Number of seedlings germinations		Average mass of a seedling (g)
	At the average per 100 seeds	(%) in comparison to control	
Control	60.0	100.0	0.37
Control + coat	63.0	105.0	0.29
T. viride+coat	58.8	98.0	0.31
Polyversum+coat	59.2	98.7	0.32
Chitosan+coat	63.2	105.3	0.31
LSD $\alpha_{=0.05}$		ns	0.041

* the same letters in a column stand for values which do not differ significantly (α=0.05)

Table 7
Occurrence of pseudo mildew (Peronospora destructor) and the onion crop in relation to the applied treatments

Facility (coat)	Pseudo mildew IR (%)	Crop ($dt \cdot ha^{-1}$)
Control	9.5	111.1 b
Chitosan+coat	5.5	106.7 b*
Chitosan+*T. viride*+coat	6.2	108.9 b
T. viride+coat	7.3	97.8 b
Polyversum+coat	8.2	102.2 b
LSD $\alpha_{=0.05}$	ns	14.47

* the same letters in a column stand for values which do not differ significantly (α=0.05)

In a plantation, researches were carried out on the possibility of limitation of pseudo mildew by spraying onion with Biosept. The obtained results show that spraying with Biosept caused significant reduction of mildew on leaves (table 8). The applied treatments favourably influenced the crop and planting quality of the collected onions.

Table 8
Impact of Biosept application on onion mildew occurrance

Facility	Number of treatments	5 of the affected plants	IR (in %)
Control	-	92.4 a	50.3 a
Biosept	4	45.3 c	15.1 c
LSD $\alpha_{=0,05}$			6.57

* the same letters in a column stand for values which do not differ significantly (α=0.05)

In the following year, material produced in an organic farm, approx. 500 onions were planted. Splendid planting material and a good stand affected the growth and development of plants. No plant with symptoms of primary infection of pseudo mildew was reported.

Harvesting of seeds

For realization of treatment of organic seeds after harvest, apparatus which allows performance of the planned treatment processes was constructed. (Domoradzki, 2005) Seeds after harvesting were cleaned, hydraulically separated, washed, dried, calibrated. Cleaned seeds after harvesting, treatment and the quality research acquire the status of organic seeds.

On experimental fields in an organic farm in Kiełpin, coated radish of Lucynka variety was sowed and the collected Supra onions obtained from the coated organic seeds were also planted. After maturation of seeds, plants were pulled out and arranged in bundles under the roof and inflorescences were dried. Threshed seeds were dried in a winnower of Petkus type with air flow.

Then, seeds were washed in water, contaminations and floating seeds were separated and then dried in a drier with warm air flow. After drying 5.1 kilo of raw seeds of radish and 4.2 kilo of raw seeds of onion were obtained. Cleaning of seeds took place during calibration on screens from 2.0 mm to 3.2 mm every 0.2 mm.

Table 9
Harvesting and cleaning procedure of seeds from an organic plantation

Item	Facility Species Variety	Plantation harvest (kg)	Plantation cleaning (kg)	Washing and floatation (kg)	Drying batch (kg)	Drying losses (kg)	Calibration (kg)	Yield of seeds (%)
4	Lucynka radish	8.00	2.90	5.10	5.00	0.50	4.50	56
5	Supra onion	5.10	0.90	4.20	4.20	0.10	4.10	80

Table 10
Calibration and germination of Lucynka radish seeds

No. of a screen	Fraction (mm)	Diameter av.d (mm)	Mass (kg)	Content (%)	Total (%)	GA acc. to ISTA (%)
1	2.0-2.2	2.10	0.148	3.28	3.28	waste
2	2.2-2.4	2.30	0.495	11.00	14.28	84
3	2.4-2.6	2.50	1.163	25.83	40.11	88
4	2.6-2.8	2.70	1.257	27.92	68.03	89
5	2.8-3.0	2.90	1.002	22.27	90.30	85
6	3.0-3.2	3.10	0.436	9.70	100.00	85
		total	4.500	100.00		

GA – germination ability

Table 11
Calibration and germination of Supra onion seeds

No. of a screen Item	Fraction (mm)	Diameter av.d (mm)	Mass (kg)	Content (%)	Total (%)	GA acc. to ISTA (%)
1	0.0-2.0	1.90	0.170	4.14	4.14	waste
2	2.0-2.2	2.10	0.429	10.46	14.60	87
3	2.2-2.4	2.30	2.206	53.81	68.41	90
4	2.4-2.6	2.50	1.230	30.00	98.41	86
5	2.6-2.8	2.70	0.047	1.15	99.55	62
6	2.8-3.0	2.90	0.018	0.45	100.00	50
			4.100	100.00		

GA – germination ability

Summary of the results of organic seeds processing

Procedure of seeds processing after harvesting consits in fast drying of seeds in order to maintain biological life and guarantees micro-biological cleanness of seeds. Seeds,which were initially dried on a field in sheaves and then under the roof are subject to further cleaning with a floating method and washing seeds in water as well as fast drying in a drier. Seeds after drying are calibrated. Only seeds prepared this way may be tightly packed and stored for further processing. The following treatments proved to be indispensable for processing of organic seeds of radish and onion: drying, floating and washing, drying wet seeds and calibration.

For trading organic seeds a required germination ability of seeds on the minimum level of 80% was assumed. Tables 9,10,11 present the list of the amount of seeds obtained from an organic plantation.

Before sowing, seeds should be treated with organic dressing or inoculated with good microroganisms, admitted for use in organic farming, (Commision regulations (EC) no. 889/2008 as of 5th September 2008 and enclosures), the list of which is extended each year.

Drying of inoculated seeds should take place in the reduced temperature on account of endurance of seeds and survivability of good microorganisms. After coating, seeds acquire protection against pathogens attack. The procedure of obtaining radish and onion seeds, developed in the University of Technology and Life Sciences in Bydgoszcz allows obtaining organic sowing material of good quality.

Conclusions

1. The paper shows that obtaining high quality sowing material from seed organic plantation, which are not chemically protected, is possible.
2. The procedure of processing organic seeds of radish and onion after harvesting was developed. It includes the processes of: cleaning, washing and hydraulic separation, drying and calibration.
3. Presowing processing of seeds affects the healthiness of crops. It consists in inoculation with fungi, coating and treatment with organic dressings.

4. Coating of organic seeds protects seeds against the attack of pathogens included in soil, which creates a coat that protects seeds to the moment of germination.
5. Health of plants on an organic plantation is ensured by useful fungi inoculation *Trichoderma viride* and *Polyversum*, eliminating colonization of pathogenic fungi.
6. After harvesting from weakly organically protected or not chemically protected organic plantations after initial cleaning, the processing of radish and onion seeds is necessary. It consists in washing and hydrostatic separation of seeds and fast drying.
7. Seeds after harvesting were subjected to calibration on screens every 0.2 mm, removing weakly germinating fractions.
8. Sowing material, which meets present quality requirements, which allow admitting sowing material for trade, was obtained.

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NOWOCZESNA METODA POZYSKIWANIA NASION EKOLOGICZNYCH CEBULI I RZODKIEWKI

Streszczenie. Opracowano technologię przygotowania nasion do siewu na plantacje ekologiczne i wybrano metody obróbki po zbiorze nasion rzodkiewki i cebuli zwyczajnej. Celem pracy było opracowanie procedury pozyskania materiału siewnego tych nasion o wysokiej jakości, zgodnej z normami nasiennymi. Opracowane procesy obejmują: separację hydrauliczną, mycie, suszenie oraz kalibrację. Przed siewem należy wykonać otoczkowanie nasion ekologicznych. Podczas otoczkowania nasion inokulowano powierzchnię nasion zarodnikami grzyba *Polyversum i Trichoderme viride* w ilości 10 szt. zarodników na nasiono lub zaprawiano chitosanem w ilości 1% do masy nasion. Suszenie nasion inokulowanych powinno odbywać się w temperaturze obniżonej do 35^{o}C, co wynikało z badań nad przeżywalnością mikroorganizmów. Uzyskano ekologiczny materiał nasienny zgodny z obowiązującymi wymaganiami jakościowymi, który skierowano do handlu.

Słowa kluczowe: nasiona ekologiczne, obróbka nasion, rzodkiewka, cebula zwyczajna