PhD THESIS

POSSIBILITIES OF ORGANIC SEED TREATMENT

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PRECEDENTS OF WORK, MAIN AIMS

Nowadays the confidence in food and the theme of food quality has more and more importance. The relevance of well-known phrase “from farm to fork” is highly emphasised by organic consumers.

The approach of organic plant production, as the closed farm system, the minimalisation energy input from outer sources, requires that the propagation material should be also organic, that is also required by the first organic regulation COUNCIL REGULATION (EEC) the No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs (Article 6.).

Organic seed is a basic element in organic research, plant breeding and seed production. The aim is to give the farmers proper and healthy seed.

Propagation material is fundamental for yield and quality of the crop of the next year. Good crop and good yield can be reached only with high-quality seed. Production of top-quality organic seed needs often special knowledge and technologies in comparison with conventional technologies.

The organic regulation should be followed not only during the production and harvesting of organic seed but later in processing. In organic farming it is not allowed to use conventional, artificial materials, hormones in seed treatment against seed borne diseases.

The demand is great but there are only several technologies and materials in organic seed treatment.

The supply of organic seeds is increasing but there are still species and varieties of short supply. In these cases - regarding the regulation and after fulfilment of some requirements – the farmers are allowed to use conventional but not treated seed. There are big discussions between seed producers, regulation makers and farmers to make stricter this possibility. It seems that the regulation will be stricter so every research is warrantable that makes organic seed healthier and competitive with conventional seed.

Aims

In organic plant production the quality of seed - the purity, germination ability and health conditions - is getting more and more important.

With sowing seed free of weed seeds and with high germination percent we can reach a homogenous and fast growing population. Fast growing population is the basis of successful regulation of weeds. Organic seeds are sown in most cases after soil fertilisation with organic matter where the nutrient supply is more slowly and the danger of contamination of the field with high amount of weed seeds is also higher. So in organic farming beside the germination ability the homogeneous emergence, fast germination (weed suppressing effect) is also very important. The speed of germination could be described with the seed vigour. The use of those

seeds that were highly vigorous under bad conditions is already known in plant production (e.g. corn cold test), so it could be successful to use e.g. this testing method in organic farming too.

In addition to seed vigour, seed health is also an important factor. Sowing healthy seed with high vigour ensures more secure and fastened emergence and a lot of problems during the production can be overtaken.

There are physical, biological and chemical methods for seed treatment allowed in organic farming to save seed health and germination ability and enhance seed vigour.

The aims of the examinations were:

- to select materials suitable to keep or enhance seed vigour,
- development of technologies using the selected materials in practice,
- to select the most representative seed vigour tests from the present methods.

In the experiment economically important species of Hungarian organic farming were examined.

During my whole work I had the aim to have all the suggested methods, materials and skills in harmony with the principles of organic farming.

MATERIALS AND METHODS

Corn (*Zea mays* L.), onion (*Allium cepa* L.) and pea (*Pisum sativum* L.) were examined. These are important species in organic plant production in Hungary. All samples were harvested in 2003. The examinations were carried out on seed samples with a lower and a higher germination percentage, but all seed samples were certified and fitted the organic standards too.

In first step the chosen treating materials - Alginit, Vetozen KR-60, Natúr Biokál 01 and thyme oil were tested against seed-borne pathogens as *Ascochyta sp.* and *Fusarium moniliforme* with agar diffusion method in vitro.

In second step the most effective material (thyme oil) were examined with soaking method. Corn seeds naturally infected with *Fusarium moniliforme* were soaked in different solutions (5000 ppm, 3000ppm, 1000 ppm, 300 ppm and 100 ppm) of thyme oil. According to the literature thyme oil has germination inhibitory effect, so after soaking also a germination test were made with every sample.

In the third test the effect of water on seed vigour (20ºC, tap water) - according to the practice of organic farmers - and Natúr Biokál 01 (30% solution), - a plant conditioner material used in organic farming in Hungary – were examined with the selected seed samples.

Soaking periods were 2, 4 and 6 hours long. After soaking, seeds were dried for 24 hours in 21 ºC temperature. After drying, germination and vigour tests were made according to the ISTA standards. The following tests were carried out:

- conductivity test,
- seedling growth test,
- cold test,
- accelerated ageing test,
- germination test in labor and
- germination test in the field.

The tests were carried out in the central Germination, Vigour and Seed Health laboratories of the National Institute of Agricultural Quality Control (NIAQC) in Budapest. Field trials were made in the Post-control variety testing station of NIAQC in Monorierdő in 2004-2005.

RESULTS

By the first examinations the effect of chosen materials on *Ascochyta spp.* and *Fusarium moniliforme* cultures were analysed visually.

Studying the 10 mm diameter pure fungi cultures on agar-dextrose substrate the Natúr Biokál 01 delayed the growing of fungus, the Alginit and Vetozen KR-60 stimulated the growing compared with the untreated control. The thyme oil mixed in the substrate inhibited the developing of the two cultures.

In the second step we examined the effect of different solutions of thyme oil on infected corn seed. After treating with 5000 ppm, 3000 ppm, 1000 ppm and 300 ppm solutions on the surface of the seed there was no infection detectable. In the control sample all seeds were infected with Fusarium.

Parallel with the seed health tests, germination tests were made also with the same samples. Regarding the control and the treatment with water the germination percentage was higher, but the paper rolls were very infected. The treatment with 5000 ppm and 3000 ppm solution gave lower than 5 % healthy germ, the high solution decreased the germination ability. With the 1000 ppm treatment the germination percentage was also only 42%.

After treatment with 300 ppm solution, 84 % of the seeds germinated healthily and reached the minimum requirement of germination percentage. Decreasing the concentration of the solution the number of emerging plants increased but there were more abnormal plants.

Results verified the negative effect of thyme oil on germination, so this material wasn't used later in the seed vigour test.

Materials from the first phase, Vetozen KR-60 and Alginit either were not involved into the vigour test because they had positive effect neither on seed health nor on seed vigour, and the use of these materials were circumstantial.

Hereafter experiments were keeping on with Natúr Biokál 01 and water to examine the effects of these materials, developing proper technologies for corn, onion and pea seed treatment.

Notations in the following table:

- negative effect,
0 equivalent value with the control,
+ positive effect,
++ significantly positive effect in $P<0,05$ level
Sample 1 – seed sample with higher germination percentage
Sample 2 - seed sample with lower germination percentage

Maize

Table 1. Summarised results of the maize sample K1 compared to the control

K1	Germination test	Accelerated ageing test	Seedling growth test	Cold test	Field test
2 hours water soaking (2V)	+	+	+	+	-
4 hours water soaking (4V)	-	++	+	-	+
6 hours water soaking (6V)	-	**0**	+	-	+
2 hours soaking in 30% Biokál solution (2B)	**0**	+	-	**0**	+
4 hours soaking in 30% Biokál solution (4B)	+	++	++	+	+
6 hours soaking in 30% Biokál solution (6B)	+	++	-	+	+

Table 2. Summarised results of the maize sample K2 compared to the control

K2	Germination test	Accelerated ageing test	Seedling growth test	Cold test	Field test
2V	**0**	-	+	+	+
4V	++	-	+	++	+
6V	+	++	++	+	+
2B	++	-	+	++	+
4B	+	-	+	+	++
6B	++	+	+	++	+

In maize the seed treatments had positive effect on germination. The effect of treatments on the sample with higher germination ability was lower. On the sample with lower germination 5 treatments (except the 2 hours long soaking in water) enhanced the germination, three times significantly (Table 1.). Seeds were more resistant against ageing and deterioration also.

The rate of stress resistance of the higher germination sample increased in every treatment, four times significantly. On the lower germination sample the 6 hours long soaking in water and 6 hours long soaking in Natúr Biokál 01 had positive effect.

In seedling growth test fast emergence at the beginning could be observed 10 times of the 12 treatments. The results of cold test showed same tendency as the germination test. In field trials every treatment, except the soaking for 2 hours in water, enhanced the vigour of both samples.

Onion

Table 3. Summarised results of the onion sample H1 compared to the control

H1	Germination test	Accelerated ageing test	Seedling growth test	Cold test	Field test
2V	-	+	-	+	-
4V	-	+	-	+	-
6V	-	++	-	+	-
2B	-	+	-	+	-
4B	-	++	++	+	0
6B	-	++	-	+	-

Table 4. Summarised results of the onion sample H2 compared to the control

H2	Germination test	Accelerated ageing test	Seedling growth test	Cold test	Field test
2V	+	++	+	+	+
4V	++	+	+	+	+
6V	+	++	-	+	-
2B	+	+	-	+	+
4B	++	+	-	++	+
6B	++	++	++	+	+

On onion sample with higher germination the treatments had positive effect on vigour in the cold test and accelerated ageing test (Table 3.).

On the sample with lower germination ability all the treatments showed positive effect (Table 4.).

The results of accelerated ageing test are very important because the onion loses its germination ability in short time.

The early sowing of onion seed is also an important factor by producing, this ability can be examined by the cold test. Every treatment enhanced the results in the test.

Pea

Table 5. Summarised results of the pea sample B1 compared to the control

B1	Germination test	Accelerated ageing test	Seedling growth test	Cold test	Field test
2V	-	-	-	-	0
4V	-	-	-	-	+
6V	-	-	-	+	-
2B	-	-	-	-	-
4B	-	-	-	+	+
6B	-	-	-	-	+

Table 6. Summarised results of the pea sample B2 compared to the control

B2	Germination test	Accelerated ageing test	Seedling growth test	Cold test	Field test
2V	-	-	-	-	0
4V	+	+	-	-	++
6V	-	-	+	+	++
2B	+	+	-	-	++
4B	++	+	++	++	++
6B	+	+	-	-	++

On pea sample with higher germination the cold test and field test gave positive results (Table 5.)

In the sample with lower germination the treatments enhanced the values of the tests (Table 6.).

Regarding the early sowing of pea seed, the results of the cold test are worth to mention, where every treatment enhanced the vigour.

During the soaking the pea's seed coat was strongly wet so seeds were more vulnerable during preparing the examinations than maize or onion. So it is suggested to dry the pea seeds longer after soaking.

By every treatment 36 samples were examined in 4 repetitions. The results of conductivity test were not analysed as it was mentioned before. Summarised results of all treatments can be seen in Table 7.

Table 7. Summarised results of the treatments

Treatments	Positive effect of 30 tests	Significantly better results from these
2 hours water soaking	13	0
4 hours water soaking	18	4
6 hours water soaking	17	2
2 hours soaking in 30% Biokál solution	15	2
4 hours soaking in 30% Biokál solution	**23**	**14**
6 hours soaking in 30% Biokál solution	19	8

From the examined 30 tests of all the three plant species the 4 hours long treatment with Natúr Biokál 01 gave positive results in most cases (23 times), and 14 of it were significantly better than the control.

Treatments with water enhanced the seed germination and vigour too.

Emergence was observed also in field trials under conditions of plant production. Results followed the results of the laboratory.

From methods offered by the literature and were used in my examination the seedling growth test and cold test for maize and onion, and in the case of pea the accelerated ageing test were the most proper to show the vigour of organic seed.

NEW SCIENTIFIC RESULTS

In vitro disinfectant effect of thyme oil on seed borne diseases as *Ascochyta pisi* and *Fusarium moniliforme* was confirmed.

Positive effect of Natúr Biokál 01 on seed vigour of maize, onion and green pea species was confirmed.

A seed treatment method was developed. My examinations confirmed that the soaking treatments after 24 hours drying enhanced the seed vigour in the valuable range. From the examined combinations the 4 hours long soaking in 30% water solution of Natúr Biokál 01 had showed positive effect in the most cases.

Seedling growth test and cold test were the most applicable from the vigour testing methods to characterize the seed vigour of maize and onion according to my examinations.

By the dicotyledonous green pea the accelerated ageing test gave the most information about seed vigour of organic seed under stress.

CONCLUSIONS AND PROPOSALS

My in vitro experiments with thyme oil confirmed the results known from the literature that thyme oil has strong antifungal effect. But the negative effect on seed germination is also mentioned. So in the second step I have examined the effect of thyme oil on germination of naturally infected maize seeds. From the applied concentrations only with the concentration of 300 ppm the seeds could reach the lower limit of germination ability. Reducing the concentration the germination decreased because of infection.

Most information about organic seed value was given by the seedling growth test. During the germination test the healthy seedlings are counted also after the cold test and the accelerated ageing test. The evaluation doesn't make difference in the state of development of seedlings. The seedling growth test makes possible the observation on different days to determine which treatment accelerates the germination or has effect of earlier and fastener growing.

In case of the conductivity test all results in all treatments showed seeds with higher vigour than the control. But this kind of treatment can query the results. Before the test, seeds were soaked in water or Biokal solution where ions could diffuse into the solutions. So during the second treatment the amount of ions in the solution was less.

After the cold tests the germination ability decreased in all cases. But this comes from the examination in which values of optimal and stressed conditions are compared. This is because the positive effects of treatments on the results of the cold test give us advantage in planning of sowing. The results of my examinations support the practice in Germany where the germination test of organic seed is done on 10ºC.

Using accelerated ageing test germination decreased in all cases especially in the case of onion. The high temperature and humidity used during the test meant strong stress conditions for seeds that can predict the longevity of seeds in commercial storage. The high decreasing of germination ability of onion seeds verifies the practical knowledge that onion seeds loose their germination ability fast. The positive effect of treatments was showed by the accelerated ageing test too.

Based on my examinations I make recommendation in two directions:

1. Proposal for seed treatment before sowing

   The value of seed was enhanced with some percent using the soaking treatment and 24 hour drying. In most cases the 4 hours long soaking in 30 % solution of Biokál gave better result than control. The treatments were

more effective on the samples with lower germination ability. So I recommend the farmers to treat seeds with lower germination with this combination.

2. Extend the range of seed testing methods

The value of seed is traditionally qualified with the germination test. I suggest to use more special testing methods. It is not unfamiliar in other countries. In Germany and Austria the 10 °C cold test is used for organic cereals.

In the case of monocotyledons I have studied (maize and onion) the cold test and the seedling growth test were well applicable. It would be worth to give also the results of these tests by in seed qualification or rather to develop a combination of these tests in the future.

In the case of pea the results of the accelerated ageing test gave best information about the vigour of organic seed under stress conditions so it would be advisable to give the values of accelerated ageing test also.

PUBLICATIONS RELATED TO THE PHD THESIS

Scientific article:

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Radics L. – Divéky-Ertsey A. – Jakab L. – Tóbiás A. (2006): Kakukkfűolajos kezelés hatásának vizsgálata fuzáriummal fertőzött kukoricamagra. 52. Növényvédelmi Tudományos Napok Budapest 2006. február 23-24. FVM, p. 69

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