Organic oat seed quality

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Overview

At least 1.8 million hectares of main cereal species are under organic management (including in-conversion areas). As some of the world's largest cereal producers (such as India, China and the Russian Federation) do not provide land use details, it can be assumed that the area is larger than shown here (Willer and Kilcher, 2009). Comparing this figure with the FAO's figure for the world's harvested cereal area of 384 million hectares (FAOSTAT, 2011), 0.5 percent of the total cereal area is under organic management.

Oat is one of the most suitable cereal species for organic farming (Lockeretz *et al.* 1981). As it has low requirements on growing conditions, it is a suitable crop for organic farming in Central Europe (Leistrumaite *et al.* 2009). There is a relatively wide range of use of oat. Naked oat is a suitable food crop (Batalova *et al.* 2010). Common oat is mostly used as a fodder crop (Stevens *et al.* 2004). It is the second most frequent crop (just after bread wheat) in the Czech organic farming system. The common oat growing area represents 5,000 hectares and its average yield rate represents 2.5 t/ha (Hrabalová, 2011).

The organic seeds used in order to establish organic crop stands must originate from plants being grown in compliance with the organic farming rules for at least one generation. Seed multiplication is an extremely difficult process. The reproduction crop stand and seed must meet the requirements of the seed certification and authorization procedure as conventional plants and seed do, but organic farming does not allow the use of any pesticides or mineral nitrogenous fertilizers, etc. Organic farmers may use certified organic seeds or farm seeds in order to establish the crop stand. They may also apply for an exception (derogation) and use the conventional untreated seed.

Objectives

The paragraph above indicates a lower productivity of the organically grown cereal crop stands. A deficiency of certified organic seeds and a serious necessity of an application of own farm saved seed are the factors that might provoke it. For this reason, a question of quality in various provenances of seed is to be answered in this poster.

Material and Methods

Varieties and seeds: Three categories of seeds have been found in the Czech Republic: certified organic seeds, conventional untreated seeds and farm seeds. Two varieties of hulled naked oat (Avena sativa L.) (Neklan, Vok) and two varieties of naked oat (Avena sativa var. nuda) (Izak, Saul) were used in the research.

Field Trials: Randomized, complete block design on organic certified trial parcels at two locations in Prague (Czech University of Live Sciences Prague and Crop Research Institute) and Ceske Budejovice (University of South Bohemia) during 2010 and 2012.

Analyses of Seeds Before Seeding and After Harvest: The method of isolation of micromycets inside an artificial nutritious soil was applied in order to evaluate the rate of grain contamination with the microscopical fungi. Laboratory germination and the energy of germination, the laboratory emergence and the energy of emergence and the thousand grain weight.

Statistical data assessment: Elementary analyses and the Statistica 9.0 (StatSoft. Inc., USA) program provided the statistical data processing. The comparison of varieties and their division into statistically different categories were provided by Tukey HSD test.

Table 1: Evaluation of health of seeds of oat (before they were sown in the exact field trials) (isolation of colonies on artificial nutrient substance)

Factor / Parameter		*Fusarium* spp. (number of colonies per 10 caryopses)	*Alternaria* spp. (number of colonies per 10 caryopses)	*Penicillium* spp. (number of colonies per 10 caryopses)	*Cladosporium* spp. (number of colonies per 10 caryopses)
Oat	Hulled	0.69±0.48^{a}	2.50±0.93^{a}	2.79±0.62^{a}	2.12±0.90^{b}
	Naked	0.69±0.49^{a}	2.49±0.77^{a}	3.75±0.37^{b}	1.19±0.96^{a}
Variety	Izak	0.67±0.51^{a}	2.67±0.91^{a}	3.79±0.39^{b}	1.52±1.18^{ab}
	Saul	0.71±0.50^{a}	2.32±0.66^{a}	3.71±0.37^{a}	0.87±0.87^{a}
	Vok	0.45±0.38^{a}	2.81±0.72^{a}	2.67±0.39^{b}	2.41±0.91^{b}
	Neklan	0.94±0.46^{a}	2.19±1.06^{a}	2.92±0.79^{ab}	1.83±0.83^{ab}
Seed origin	E	0.42±0.39^{a}	2.60±0.92^{a}	3.19±0.60^{a}	1.68±1.05^{a}
	C	0.83±0.51^{a}	2.59±0.69^{a}	3.41±0.50^{a}	1.78±1.01^{a}
	F	0.82±0.48^{a}	2.31±0.95^{a}	3.24±0.44^{a}	1.52±0.76^{a}
Year	2010	0.35±0.49^{a}	1.84±0.76^{a}	3.15±0.58^{a}	1.19±0.75^{a}
	2011	0.92±0.48^{a}	2.91±0.85^{c}	3.45±0.55^{a}	2.12±0.86^{c}
	2012	0.81±0.42^{a}	2.75±0.92^{ab}	3.21±0.46^{a}	1.67±1.20^{ab}
Total		0.69±0.48	2.50±0.85	3.27±0.50	1.66±0.93

Letters indicate the statistically significant differences between the studied data files. The significance level is P≤0.05.

Table 2: Evaluation of biological characteristics of seeds of oat (before they were sown in the exact field trials)

Factor / Parameter		Energy of germination (%)	Laboratory germination capacity (%)	Energy of emergence (%)	Laboratory emergence (%)
Oat	Hulled	80.35±12.44^{a}	87.29±10.45^{a}	70.93±11.54^{a}	81.42±9.87^{a}
	Naked	88.41±12.21^{b}	90.21±10.19^{a}	79.28±9.68^{b}	84.45±8.99^{a}
Variety	Izak	93.71±9.40^{a}	96.12±8.91^{b}	84.92±8.70^{b}	88.43±8.74^{b}
	Saul	83.10±14.97^{b}	84.31±11.82^{a}	73.64±10.66^{a}	80.47±11.24a
	Vok	75.49±15.96^{c}	83.49±12.91^{a}	67.38±12.39^{a}	77.41±11.62^{a}
	Neklan	85.21±8.98^{b}	91.10±7.61^{b}	74.48±10.07^{a}	85.42±6.00^{ab}
Seed origin	E	82.98±14.16^{a}	88.37±11.24^{ab}	74.38±10.79^{ab}	81.60±9.78^{a}
	C	88.30±12.17^{b}	93.28±8.39^{b}	79.03±9.94^{b}	86.48±6.64^{a}
	F	81.85±10.89^{a}	84.63±11.48^{a}	71.93±10.86^{a}	80.73±11.71^{a}
Year	2010	90.80±9.11^{a}	91.74±7.10^{b}	74.13±7.83^{a}	82.29±6.15^{ab}
	2011	77.80±14.94^{b}	83.15±13.06^{a}	73.57±13.55^{a}	78.12±12.43^{a}
	2012	83.58±12.66^{ab}	92.31±11.12^{b}	77.63±10.16^{a}	88.39±10.41^{b}
Total		84.38±12.33	88.75±10.32	75.11±10.61	82.94±9.43

Letters indicate the statistically significant differences between the studied data files. The significance level is P≤0.05.

Table 3: Evaluation of health of oat seeds (after harvest) (isolation of colonies on artificial nutrient substance)

Factor / Parameter		Fusarium spp. (number of colonies per 10 caryopses)	Alternaria spp. (number of colonies per 10 caryopses)	Penicillium spp. (number of colonies per 10 caryopses)	Cladosporium spp. (number of colonies per 10 caryopses)
Oat	Hulled	1.28±0.81^{b}	4.08±2.13^{b}	2.55±1.51^{a}	6.13±5.00^{D}
	Naked	0.77±0.60^{a}	2.27±1.50^{a}	5.43±2.67^{C}	4.84±3.48^{a}
Variety	Izak	0.83±0.40^{a}	2.31±1.31^{a}	5.51±2.68^{C}	5.19±3.27^{a}
	Saul	0.71±0.65^{a}	2.24±1.69^{a}	5.33±2.61^{C}	4.48±3.70^{a}
	Vok	1.41±0.82^{C}	4.29±2.10^{C}	2.56±1.66^{a}	7.03±5.14^{D}
	Neklan	1.15±0.80^{ab}	3.88±2.19^{b}	2.54±1.39^{a}	5.23±4.78^{a}
Seed origin	E	1.07±0.75^{a}	2.98±1.72^{a}	3.86±2.02^{a}	5.14±4.40^{a}
	C	1.14±0.92^{a}	3.15±1.73^{a}	4.28±2.09^{a}	5.92±3.82^{a}
	F	0.87±0.54^{a}	3.41±2.16^{a}	3.83±2.13^{a}	5.40±4.62^{a}
Year	2010	1.53±0.78^{b}	3.25±2.68^{ab}	3.80±2.13^{a}	9.23±4.22^{D}
	2011	0.97±0.80^{a}	3.88±1.93^{b}	4.25±2.97^{a}	3.19±1.60^{a}
	2012	0.96±0.55^{a}	2.40±0.89^{a}	3.92±2.67^{a}	4.03±2.36^{a}
Location	ČZU	1.44±0.95^{C}	3.00±1.85^{a}	3.70±2.08^{a}	6.30±4.64^{D}
	JU	0.88±0.58^{ab}	3.34±1.76^{a}	4.01±2.01^{a}	4.06±2.80^{a}
	VÚRV	0.75±0.57^{a}	3.20±1.80^{a}	4.25±2.39^{a}	6.10±5.19^{D}
Total		1.03±0.72	3.18±1.82	3.99±2.09	5.49±4.24

Letters indicate the statistically significant differences between the studied data files. The significance level is P≤0.05.

Table 4: Evaluation of biological characteristics of oat seeds (after harvest)

Factor / Parameter		Energy of germination (%)	Laboratory germination (%)	Energy of emergence (%)	Laboratory emergence (%)	Yield rate (t.ha^{-1})
Oat	Hulled	91.93±5.48^{a}	94.09±4.34^{a}	83.55±6.34^{a}	88.11±4.16^{a}	3.98±1.50^{b}
	Naked	92.47±4.29^{a}	94.14±3.30^{a}	81.47±10.57^{a}	87.29±7.44^{a}	2.49±1.17^{a}
Variety	Izak	93.52±3.97^{a}	95.00±2.99^{a}	83.21±8.06^{a}	89.32±4.12^{a}	2.71±1.10^{a}
	Saul	91.43±4.75^{a}	93.27±3.74^{a}	79.73±12.80^{a}	85.27±9.91^{a}	2.27±1.21^{a}
	Vok	90.21±4.99^{a}	92.93±4.40^{a}	82.73±5.88^{a}	86.89±3.90^{a}	3.91±1.46^{b}
	Neklan	93.64±5.50^{a}	95.23±4.05^{a}	84.37±6.79^{a}	89.34±4.99^{a}	4.04±1.56^{b}
Seed origin	E	92.42±5.51^{a}	94.28±4.08^{a}	83.38±7.53^{a}	88.37±4.54^{a}	3.21±1.28^{a}
	C	91.95±5.14^{a}	93.82±4.18^{a}	81.04±11.62^{a}	87.11±8.00^{a}	3.36±1.39^{a}
	F	92.23±4.10^{a}	94.24±3.29^{a}	83.10±6.19^{a}	87.64±5.01^{a}	3.13±1.35^{a}
Year	2010	92.82±4.42^{a}	94.88±3.29^{a}	77.24±7.89^{a}	85.89±6.88^{a}	2.67±1.25^{a}
	2011	89.77±6.44^{a}	91.76±4.69^{a}	81.65±9.55^{ab}	86.46±6.82^{a}	3.78±1.35^{b}
	2012	94.00±3.75^{a}	95.70±2.96^{a}	88.63±8.12^{b}	90.77±3.42^{a}	3.25±1.42^{ab}
Locality	ČZU	92.46±4.35^{a}	94.25±3.99^{a}	83.57±9.00^{a}	87.81±6.62^{a}	4.60±1.48^{b}
	JU	93.16±3.91^{a}	94.78±2.84^{a}	82.98±6.45^{a}	87.71±3.92^{a}	2.84±1.33^{a}
	VÚRV	90.99±6.20^{a}	93.30±4.59^{a}	80.98±10.08^{a}	87.60±6.87^{a}	2.26±1.22^{a}
Total		92.20±4.89	94.11±3.82	82.51±8.45	87.71±5.80	3.23±1.34

Letters indicate the statistically significant differences between the studied data files. The significance level is P≤0.05.

Results / Conclusions

We studied the quality of hulled and naked oat seeds of various origin for three years – the certified organic seeds, the farm organic seeds and the conventional untreated seeds. Results of our research have shown the farm seeds are not of inferior quality or worse health to the certified organic seeds of the conventional seeds. Seeds of the above-mentioned cereal varieties were little contaminated with the studied and evaluated micromycetes. The contamination rate is mostly determined by the year and the trial locality conditions. The studied biological characteristics of seeds were mostly good. In that case, the year and the trial locality conditions have had a negligible impact on them.

Working on the assumption of the results of our research, we can say that a well-arranged cropping, a good forgoing crop and a respect of agrotechnological principles lead to a production of high quality organic farm seeds. The quality of such organic farm seeds is similar to the quality of certified organic seeds. There might be some problems in the localities where certain pathogens and microorganisms live (e.g. *Fusarium* spp.), or in certain years when the pathogens and microorganisms emerge.

Keywords: *Fusarium* spp., health and biological characteristics, seed, organic farming, oat

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