Foliar fungicide and environments on the physiological quality of oat seeds[1]

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ABSTRACT – The oat crop is of great economic importance and seed production depends on several factors (biotic and abiotic) that can alter its quality. Thus, the study aimed to evaluate the physiological quality of oat seeds produced with and without application of foliar fungicide in contrasting environments. The experimental design was a randomized block design in a factorial 6x2 (cultivar x fungicide) for each site, with four replications. The physiological quality of seeds was evaluated by grain yield, germination, first count, accelerated aging, moisture content after accelerated aging, seedling length, seedling dry weight, electrical conductivity and seedling emergence in field. Data were subjected to joint and individual analysis of variance, and means were compared by Tukey's test at 5%. Grain yield in Mauá da Serra is superior to Londrina, Parana State – Brazil, but the seed quality is lower, although all cultivars have shown germination above 90% in the two cultivation sites. Cultivars FAEM 6 DILMASUL and UPFA OURO showed no disease, indicating possible resistance. The application of the product has a beneficial effect on seed germination and vigor, even in the absence of disease.

Index terms: *Avena sativa* L., cultivars, germination, vigor.

Fungicida foliar e ambientes de cultivo na qualidade fisiológica de sementes de aveia branca granífera

RESUMO – A aveia branca é uma cultura de grande importância econômica e a produção de sementes depende de diversos fatores (bióticos e abióticos) que podem alterar sua qualidade. Dessa forma, o trabalho teve por objetivo avaliar a qualidade fisiológica de sementes de aveia branca produzidas com e sem aplicação de fungicida foliar em ambientes contrastantes. O delineamento experimental foi em blocos casualizados, em esquema fatorial 6x2 (cultivares x fungicida), para cada local, com quatro repetições. A qualidade fisiológica das sementes foi avaliada pelos testes de rendimento de grãos, teor de água, germinação, primeira contagem de germinação, envelhecimento acelerado, teor de água após o envelhecimento acelerado, comprimento de plântulas, massa de matéria seca de plântulas, condutividade elétrica e emergência de plântulas em escala de campo. Os dados foram submetidos à análise de variância individual e conjunta, as médias comparadas pelo teste de Tukey a 5%. O rendimento de grãos em Mauá da Serra é superior a Londrina, estado do Paraná, Brasil, porém a qualidade fisiológica da semente é inferior, embora todas as cultivares tenham apresentado porcentagem de germinação superior a 90% nos dois locais de cultivo. As cultivares FAEM 6 DILMASUL e a UPFA OURO não apresentaram doença, indicando possível resistência. Há efeito benéfico da aplicação do produto na germinação e vigor, mesmo na ausência da doença.

Termos para indexação: *Avena sativa* L., cultivares, germinação, vigor

Introduction

The cultivation of oat has assumed a prominent position due to growth in no-till systems combined with crop rotation. The oat species most commonly cultivated are: common oat (*Avena sativa* L.), red oat (*Avena byzantina* C. Koch) and black oat (*Avena strigosa* Schreb). Black oat is indicated for the production of forage, and the grains of cultivars of common and red oat, in addition to the production of forage, can be used in industry (Floss, 2007).

The common oat is an annual winter Poaceae economically feasible for grain yield with excellent nutritional quality for

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human and animal consumption. Still, due to its nutritional characteristics, mainly by the content and quality of dietary fibers, human consumption of oats has increased (Slavin, 2004; Wood, 2007).

This culture is an alternative for the management of crop rotation used in winter, with high growth of the cultivated area in recent years, especially grains for commercialization and industrialization. Still, because it produces excellent quality straw, which provides good ground cover, it favors the deployment of summer crops, mainly in no-till system (Hartwig et al., 2007; Carvalho et al., 2008). The prospect area of oats to be harvested in 2013 is 169 thousand hectares, with a total production of 361 thousand tons. Of these, an area of 62 thousand hectares of cultivated oats are in the state of Paraná, expected to produce 141 thousand tons of grain, while for Rio Grande do Sul, the prospect is 100 thousand hectares, with a production of 212 thousand tons (CONAB, 2013).

The proper development of the culture is directly related to the use of high quality seeds, generating, thus, vigorous plants, uniform population, absence of diseases transmitted via seeds, which are factors that can determine a profitable production (Marcos-Filho, 2005; Scheeren et al., 2010). Now low-quality seeds result in reductions in the rate of emergence and uniformity, yielding suboptimal populations of plants (Hőfs et al., 2004).

The physiological quality of the seed, as well as the chemical composition and nutritional quality of oat, which are relatively higher than other cereals, vary according to the cultivation location and genotype (Silva et al., 2003). Genotypes differ in agronomic characteristics, which, among other factors, determine the choice of a cultivar such as: cycle, plant height, grain/straw ratio, grain/panicle number, yield and quality of grains or seeds (Noro et al., 2003).

The differences in environment are evidenced by the presence of interaction genotype x environment (Benin et al., 2003; Lorencetti et al., 2004); the effects of this interaction may result from factors such as: climatic conditions, soil fertility, disease incidence and techniques involved in the steps of seed production.

The oat crop is affected by some diseases throughout its life cycle, including leaf rust (*Puccinia coronata)* and stem rust (*Puccinia graminis)*. Another disease observed among leaves, in terms of incidence and severity, is spot blotch (*Cochliobolus sativus*). In good years, such diseases may cause a decrease in forage production and losses exceeding 50% in grain yield (Martinelli et al., 2009), thereby increasing the magnitude of the interaction between genotypes and the environment.

To control these diseases, cultivation of resistant or tolerant genotypes and fungicide application as a way to increase the genotypic stability in environments with high incidence of pathogens, aiming at reducing the interaction genotype x environment, has been suggested, indicating that oat cultivars express higher yield potential and better quality seeds (Federizzi et al., 1993).

The study aimed to evaluate the physiological quality of common oat seeds produced with and without the application of foliar fungicide in contrasting environments.

Materials and Methods

The study was conducted with seeds from trials conducted by the Agronomic Institute of Paraná, crop year 2011 in Londrina and Mauá da Serra - Paraná, Brazil, regions with different soil and climatic characteristics. The climate of the Mauá da Serra region, according to Köppen, is type Cfb: temperate with cool summers with no defined dry season, and Londrina is type Cfa: humid subtropical with hot summer (IAPAR, 2012). Londrina is located at an altitude of 610 m and latitude south 23º 23’, and Mauá da Serra is at 847 m of altitude and is located at latitude south 23º 58’. The soil of the Londrina region is characterized as eutrophic Red Latosol and Mauá da Serra as dystrophic Red Latosol (Embrapa, 2006). The climatic data for the period of the experiment are shown in Figure 1.

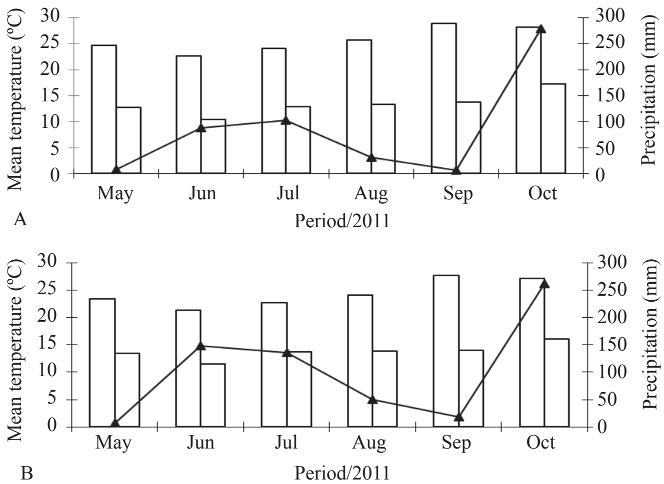

Figure 1. Rain precipitation data (columns) and mean temperature (line) observed in the municipalities of Londrina - PR (A) and Mauá da Serra - PR (B) during the crop cycle of common oat, starting on the date of planting for each location.

The experimental design at each location was in randomized blocks, in a 6x2 factorial (cultivars x with and without fungicide) with four replications. Seeds of six oat cultivars of late, early and intermediate cycle, recommended by CBPA (2006), were used (Table 1). Data from periods of full flowering and full maturity of cultivars of common oat grains of Londrina and Mauá da Serra are shown in Table 2.

Seeds were sown on May 11th, 2011 in Mauá da Serra and May 13th, 2011 in Londrina, with a density of 300 seeds/m². The spacing was 0.17 m and each plot consisted of five rows of 5 m length. Three central lines that brought about the floor area of 2.55 m^2 were used. Fertilization was conducted with 265 $kg.ha^{-1}$ of the formula 10-30-10 (NPK) in the two cultivation sites. The data of the chemical characteristics of the sites used in the test of oat cultivars are listed in Table 3. The experiment was conducted under natural rainfall conditions.

Table 1. Common oat cultivars used in this study and their respective breeders.

Cultivar	Cycle	Release	Breeder
IAC 7	premature	1992	IAC
URS Taura	premature	2009	UFRGS
IPR Afrodite	intermediate	2011	IAPAR
FAEM 6 Dilmasul	intermediate	2011	UFPel
UPF 18	late	1999	UPF
UPFA ouro	late	2011	UFRGS

Source: Adapted from LORENCETTI et al. (2004).

Table 2. Times of full flowering and full maturity of the six cultivars of common oat in the sites 1 and 2 with and without fungicides.

Cultivar	Full flowering (E-F days)*			
	Site 1		Site 2	
	With fungicide	Without fungicide	With fungicide	Without fungicide
IAC 7	67	67	74	75
URS TAURA	74	70	80	81
IPR AFRODITE	74	77	80	82
FAEM 6 DILMASUL	75	77	87	87
UPF 18	88	88	95	94
UPFA OURO	84	82	87	85
Cultivar	Full maturity (E-M days)*			
	Site 1		Site 2	
	With fungicide	Without fungicide	With fungicide	Without fungicide
IAC 7	95	95	108	108
URS TAURA	101	100	113	111
IPR AFRODITE	107	106	122	126
FAEM 6 DILMASUL	107	106	124	117
UPF 18	118	116	127	127
UPFA OURO	113	116	126	127

*E-F days from emergence to flowering.
*E-M days from emergence to maturity.

Table 3. Chemical characteristics of the soil in the sites used in the tests of common oat cultivars.

Site	$mg.dm^{-3}$	$g.dm^{-3}$	pH	$Cmol_c.dm^{-3}$ of soil							%	
	P	C		Al	H+Al	Ca	Mg	K	*S	*T	*V	*Al
Site 1	12.7	15.79	4.50	0.26	6.20	2.76	1.62	0.35	4.73	10.93	43.27	5.21
Site 2	14.4	33.98	4.70	0.10	7.75	4.52	1.47	0.33	6.32	14.07	44.91	1.55

*S = Sum of bases, T = Cation exchange capacity, V = Base saturation, Al = aluminum saturation. (P and K: Mehlich; Ca, Mg and Al: KCl M; pH: CaCl2 0.01 M).

The control of diseases in the tested plots was accomplished by foliar spraying of the fungicide Tebuconazole, with two applications made at 60 days after sowing with the appearance of first pustules and at 90 at reappearance of new pustules at doses suggested by the CBPA (2006). Culture practices were performed as required and recommended for the crop and harvest performed at the stage of full maturity.

The seed quality evaluations were performed immediately after harvest, through the following tests: *Grain yield:* the three central lines of each plot were collected and subsequently taken to grain weighing, and the estimate of the plot value for kilograms per hectare was adjusted to 13% moisture. *Water content:* four replicates of 50 grams of seeds were used by oven method at 105 ± 3 °C for 24 hours (Brasil, 2009). *Germination:* conducted with pre-cooling at a temperature of 10 °C for seven days for breaking dormancy of seeds. Four replications of 50 seeds were distributed in germination paper roll moistened with water at a ratio of 2.5 times the mass of the substrate. After seven days the paper rolls were placed in plastic bags and kept in a germination chamber at 20 °C. The evaluation consisted of two counts at five (first count) and ten days (second count) after seeding (Brasil, 2009). *Accelerated aging:* the methodology proposed by AOSA (1983) and described by Marcos-Filho (1999) was used. Four replicates of 70 seeds were distributed on an aluminum mesh, fixed in plastic "gerbox" with 40 mL of water. The boxes containing the seeds were held in the aging chamber at 41 °C for 48 hours. Next, four replicates of 50 seeds were subjected to germination test, according to Brasil (2009) and four replications of 20 seeds were used to determine the seed water content after aging, by oven method at 105 ± 3 ºC, according to RAS (Brasil, 2009). *Conductivity test*: four replications of 50 shelled seeds, previously weighed, were put to soak in 75 mL of distilled water for a period of 24 hours at 25 °C (Vieira and Krzyzanowski, 1999). After soaking, the electrical conductivity of the solution was determined by conductivity meter DIGIMED, model 21, with the results expressed in $\mu S.cm^{-1}.g^{-1}$ of seeds. *Seedling emergence in the field*: four replicates of 50 seeds that were sown between 2.5 to 3.0 cm deep in 2.0 m rows, spaced 30 cm apart. The evaluation was performed at 14 days after sowing, noting the emerging seedlings, and the result expressed as a percentage of emerged seedlings (Nakagawa, 1994). *Seedling length:* the method used was moistened paper roll in the ratio of 2.5 times the volume of water in relation to the mass of dry paper, described by Nakagawa (1999), adapted from AOSA (1983). Four replicates of 15 seeds were sown on two sheets of paper, distributed along a line in the upper third of the paper. The paper rolls containing the seeds were placed in plastic bags and taken to the germinator at 20 ºC. After five days, the total length of normal seedlings was assessed with the aid of a millimeter ruler. *Dry weight of seedlings*: normal seedlings from the seedling length test were placed in paper bags and taken to the forced air circulation oven at 65 ± 5 ºC until constant weight, with results expressed in grams per seedling.

Data were subjected to individual and joint analysis of variance of experiments and means were compared by Tukey's test at 5% probability. The sources of variation considered in the joint analysis were: Site, Block (Site), Cultivar, Fungicide, Interaction Cultivar*Fungicide and Interaction Site*Treatment. Treatment corresponds to the combination of factors Cultivar and Fungicide, i.e. Site*Cultivar, Site*Fungicide and Site*Cultivar*Fungicide, with 11 degrees of freedom. When the Interaction Site*Treatment was significant, individual analyzes were used.

Results and Discussion

The joint analysis of variance showed a significant effect of site and cultivars for most of the variables tested, highlighting an isolated effect of site and cultivar for grain yield, germination, overall seedling length, except first germination count, which observed only site effect (Table 4). The effect of fungicide application was observed only for the variable water content after accelerated aging and seedling emergence in the field. Moreover, we observed a significant interaction cultivar x fungicide in most tests except for grain yield, water content after accelerated aging, seedling emergence in field and dry matter of seedlings.

Table 4. Summary of joint analysis of variance (Prob.>F) of grain yield (RGD (kg.ha^{-1}), water content (TA), germination (GERM%), first germination count (FGC%), accelerated aging (AA%), water content after accelerated aging (WCAA%), electrical conductivity (EC μS.cm^{-1}.g^{-1}), seedling emergence in the field (SEF%), total seedling length (TSL cm), dry weight of seedlings (DWS g), originated from seeds of common oat in the presence and absence of fungicide application.

Character	Site	BL (Site)	Cultivar	Fungicide	Cultivar*Fungicide	Site*Treatment	CV (%)
RGD	11.33**	1.77ns	16.05**	2.70ns	0.19ns	1.78ns	10.64
TA	150.99**	0.99ns	3.23*	14.83**	4.65**	3.17**	2.58
GERM	6.30*	0.30ns	8.19**	0.58ns	3.10*	0.50ns	1.90
FGC	34.46**	0.36ns	1.74ns	0.28ns	3.34**	0.60ns	3.24
AA	88.29**	0.64ns	5.15**	5.98*	2.54*	2.58**	5.96
WCAA	3.42ns	0.76ns	0.43ns	4.75*	1.95ns	1.27ns	7.33
EC	5.48*	0.89ns	33.53**	1.22ns	6.36**	5.07**	11.03
SEF	0.04ns	0.66ns	1.52ns	3.89*	0.19ns	0.63ns	13.21
TSL	467.04**	0.65ns	15.30**	0.14ns	3.43**	0.91ns	7.11
DWS	17.65**	0.97ns	50.74**	0.01ns	1.94ns	2.65**	10.45

* and ** - significant at 5 and 1% probability, respectively. ns - not significant.

In the individual analysis of variance, it was possible to observe effects of cultivars for most variables, both for Londrina (Site 1), and for Mauá da Serra (Site 2), except in the evaluation of water content and accelerated aging of seeds from Londrina (Table 5). The effect of fungicide application was observed in the water content and accelerated aging test of seeds from Mauá da Serra. Furthermore, it was possible to detect a significant interaction cultivar x fungicide for the water content and electrical conductivity test of seeds from Mauá da Serra. In Londrina, in the plots that did not receive a fungicide application, Rust incidence was equal to 50% with severity equal to or greater than 50% for the cultivars IAC 7 and UPF 18. In Mauá da Serra, Rust incidence was equal to 40%, 10% and 20%, with severity greater than or equal to 70% for cultivars IAC 7, URS TAURA and IPR AFRODITE, respectively. The control was efficient in plots receiving an application of the product.

For grain yield (kg.ha^{-1}) there was a significant effect of the study sites, highlighting higher seed yield in Mauá da Serra (Table 6), in agreement with Benin et al. (2003), which observed a significant difference in the genetic potential of oat between environments. Cultivars responded differently, with higher grain yield for cultivars IPR APHRODITE and FAEM 6 DILMASUL. The cultivar UPF 18 showed a lower yield compared to the other cultivars. Regarding the application of fungicide, no significant effect was observed on grain yield in both cultivation sites.

Table 5. Summary of individual analysis of variance for water content, accelerated aging, electrical conductivity, dry weight of seedlings originated from common oat seeds from Londrina – PR (1) and Mauá da Serra - PR (2) in the presence and absence of fungicide application.

Character	Site	Block	Cultivar	Fungicide	Cultivar*Fungicide	CV (%)
Water content (%)	1	0.97ns	0.13ns	0.04ns	1.50ns	2.96
	2	0.35ns	8.52**	45.62**	5.08**	2.06
Accelerated aging (%)	1	0.88ns	1.15ns	0.01ns	14.01ns	3.37
	2	0.59ns	4.86**	7.28*	2.00ns	8.11
Electrical conductivity ($\mu S.cm^{-1}.g^{-1}$)	1	1.19ns	19.94**	0.48ns	1.98ns	8.03
	2	0.77ns	21.06**	0.76ns	5.84**	13.59
Dry weight of seedlings (g)	1	0.82ns	19.15**	0.26ns	1.40ns	10.67
	2	1.11ns	35.45**	0.28ns	1.60ns	10.24

* and ** - significant at 5 and 1% probability, respectively. ns - not significant.

The initial water content of oat seeds produced in Londrina has not changed in terms of sources of variation and the average was 10.2 to 10.5. For Mauá da Serra, a significant interaction cultivar x fungicide was observed in the water content of the seeds. Such variations of 9.04 to 10.13 in the water content of the seeds are possibly linked to cycle differences among cultivars, which caused maturation to occur in different periods (Table 2), as well as the action of fungicides in regulating the cycle and uniformity of maturation. According to Marcos-Filho (1999) the initial water content is a key factor in standardizing the evaluation of quality and achieve consistent test results. Variations of initial water content observed in the seeds were less than 2%, indicating that this parameter was in the range suitable for performing the oat seeds quality tests. However, large differences may lead to differences in the intensity of seed deterioration (Tunes et al., 2008).

Germination was statistically altered by study sites, however, the difference between sites was only 1%. In the presence of fungicide applications, no significant difference among cultivars was observed. The results corroborate Teló et al. (2012) in rice cultivars, in which the conduction of two fungicide applications provided similar germination among cultivars. Already in the absence of fungicide applications, the cultivar UPFA OURO presented seeds with lower germination compared to the other cultivars, although with value greater than 90%. The cultivar UPFA OURO, when produced with fungicide applications, showed a germination percentage statistically greater than that produced without fungicide.

In the first count of the germination test, common oat seeds originating from Londrina resulted in higher average (96%). With fungicide applications, no significant difference among the cultivars evaluated was observed. In the absence of fungicide use the cultivar IAC 7 had a higher percentage of normal seedlings (96%) and the UPFA OURO had a smaller percentage compared to the other cultivars, indicating slower germination, therefore, lower seed vigor. According to Menezes and Silveira (1995), the larger amount of normal seedlings obtained in the first count of the germination test does not always determine the highest final germination, because the individual seed vigor can manifest itself variably in lots of low or intermediate quality, as well as the continuity of the germination test after the fifth day favors the expression of the maximum germination potential, even in seeds that have less vigor. It can be seen that the cultivar UPFA OURO, when produced with fungicide applications, showed a germination percentage in normal seedlings statistically greater than that produced without fungicide.

In the accelerated aging test seeds originating from Londrina presented individual average of 95% and from Mauá da Serra, 85%. There was no cultivar and fungicide effect in the experiment performed in Londrina. To Mauá da Serra, there was a cultivar and fungicide effect, especially the cultivar IAC 7 that showed the highest germination percentage (93%) not differing from IPR AFRODITE. Garcia and Menezes (1999), working with seeds of ryegrass, black oats and millet, observed that seed with low vigor have greater reduction of viability when subjected to conditions of high temperature and humidity, while more vigorous seeds usually retain their ability to produce normal seedlings and have high germination after being subjected to aging. According to the results observed by Souza et al. (2009), who used the accelerated aging test to estimate the vigor of lots of black oats seeds, the germination percentage remained high within the commercial standards, ie, above 75%. This fact is extremely important, since one of the objectives of the test is to identify significant differences in the physiological quality of marketable lots, especially among those with similar germination.

Table 6. Mean values and interaction cultivar x fungicide for grain yield, water content, germination, first count of germination, accelerated aging, water content after accelerated aging, electrical conductivity and seedling emergence in the field originated from oat seeds from Londrina – PR (1) and Mauá da Serra - PR (2) in the presence and absence of fungicide application.

Grain yield (kg.ha^{-1})									
			Cultivar						
Site	Mean	Fungicide	IAC 7	URS TAURA	IPR AFRODITE	FAEM 6 DILMASUL	UPF 18	UPFA OURO	Mean
1	4865 B								
2	5294 A								
		With							5184 A
		Without							4975 A
		Mean	4588 cb	5171 ba	5702 a	5703 a	4125 c	5188 ba	
Water content (%)									
1	10.3	With							10.3 A
		Without							10.4 A
		Mean	10.3 a	10.2 a	10.4 a	10.6 a	10.2 a	10.3 a	
2	29.6	With	9.8 aA	9.3 bcB	9.0 cB	9.5 abB	9.8 aB	9.6 abB	
		Without	9.6 aB	9.7 bA	9.8 abA	10.1 aA	10.1 aA	10.0 abA	
Germination (%)									
1	99A								
2	98B								
		With	98 aA	97 aA	100 aA	100 aA	97 aA	97 aA	
		Without	100 aA	98 aA	100 aA	98 aA	98 aA	94 bB	
First germination count (%)									
1	96A								
2	93 B								
		With	93 aA	93 aA	95 aA	96 aA	92 aA	94 aA	
		Without	96 aA	96 aA	95 aA	94 abA	95 aA	91 bB	
Accelerated aging (%)									
1	95	With							95 A
		Without							95 A
		Mean	95a	95 a	96 a	93 a	93 a	95 a	
2	84	With							87 A
		Without							82 B
		Mean	93 a	80 b	89 ab	82 b	82 b	80 b	
Water content after accelerated aging (%)									
1	27,8A								
2	27,1A								
		With							27,9 A
		Without							26,9 B
		Mean	27.6 a	27.0 a	27.9a	27.4 a	27.9 a	27.5 a	
Electrical conductivity (µS.cm^{-1}.g^{-1})									
1	121.6	With							120.6A
		Without							122.6A
		Mean	104.4 c	119.9 bc	116.4 bc	109.5 bc	134.5 ab	145.0 a	
2	115.4	With	82,7 cB	84.3 cA	92.7 bcB	148.4 aA	122.3 abA	149.9 aA	
		Without	107,3 bcA	82.3 cA	123.0 bA	103.3 bcB	129.3 abA	158.9 aA	
Seedling emergence in the field (%)									
1	77,0 A								
2	76,6 A								
		With							78.8 A
		Without							74.7 B
		Mean	82.9 a	73.7 a	76.5 a	75.7 a	76.1a	75.7 a	

Means followed by the same uppercase letter in the column and lowercase in the line, do not differ by Tukey's test at 5% probability. With fungicide (With); Without fungicide (Without).

The aged seeds showed increases in their water content after aging compared to the initial water content, with significant effect only of the fungicide with higher water content after aging in seeds produced by applying the product. Marcos-Filho (1999) points out that the moisture content of the seeds after aging is a key indicator of uniformity of test conditions and that 3-4% variations between samples are considered tolerable. The differences between mean water content after aging observed in this study were less than 4%, thus not compromising the reliability of the results of the accelerated aging test.

In the electrical conductivity test applied to Londrina seeds tests, significant differences were observed among cultivars with higher conductivity for UPFA OURO. According to Rodrigues et al. (2006) there are several factors that can affect the results of electrical conductivity, among which are highlighted the quality and quantity of water used for immersion, immersion period, humidity, mass, quantity, age and integrity of the seeds, genotype and temperature. A significant interaction cultivar x fungicide was observed for Mauá da Serra. In studies to assess the quality of seeds of rice cultivars with foliar fungicide application, Teló et al. (2012) also observed an interaction between cultivar x fungicide. The cultivar IAC 7 with fungicide, showed the lowest conductivity and UPFA OURO showed a greater value, not differing from FAEM 6 DILMASUL. URS TAURA, without fungicide, showed the lowest electrolyte leakage, indicating greater vigor, and UPFA OURO showed higher electrical conductivity, indicating less force, as suggested by studies with other cultures (Vieira and Krzyzanowski, 1999; Dias et al., 2006.). The use of fungicide increased the electrical conductivity in cultivars IAC 7 and IPR AFRODITE and decreased in cultivar FAEM 6 DILMASUL. Differences in the values of electrical conductivity may also be related to early deterioration of seeds caused by several factors, namely: late crops, rainfall prior to harvest and drying and/or storage (Höfs et al., 2004).

On seedling emergence in the field there was an effect only on the application of fungicide. The emergence showed a lower percentage in relation to the germination and vigor tests in the same period in the laboratory, but the averages were above 75%. Non-controlled environmental conditions in the field possibly caused a decrease in the emergence of the same (Copeland and McDonald, 1985). Reductions in seedling emergence in the field were also observed by Schuch et al. (2000), when assessing seedling emergence and growth of black oats seeds.

The differences in total seedling length were significant for the site, with higher values observed in seedlings from seeds produced in Londrina (Table 7). The interaction cultivar x fungicide was significant, and in the presence of fungicide applications the cultivars differed. In the absence of fungicide applications, greater length was observed for IPR AFRODITE and lowest for the cultivar URS TAURA. The use of fungicide decreased the total length of the seedlings of the cultivar UPF 18. The significance of the interactions to the total length of seedlings, indicating that the set of genotypes responded differently to fungicide application form, which is consistent with reports from Benin et al. (2003) and Lorencetti et al. (2004).

For the dry weight of seedlings, both for Londrina and for Mauá da Serra, statistical differences among cultivars was observed, indicating that UPFA OURO showed higher mass, both in Londrina and in Mauá da Serra. Effects of seed quality on the production of leaf dry matter were also observed by Schuch et al. (2008) in black oats seeds and by Höfs et al. (2004) in rice seeds. Vigorous seeds originate seedlings with the highest growth rate, due to its having greater processing capacity and the supply of reserves in storage tissues and increased their incorporation through embryonic axis. Such mechanism can result in faster and more uniform emergence with larger seedlings, providing superior growth rate in the initial seedling growth, influencing the leaf area index and dry matter accumulation. However, the effect of physiological quality of seeds observed in the initial plant growth tends to reduce with its growth (Schuch et al., 2008).

In the general results obtained by the tests for assessing the physiological quality of common oat seeds, we observed a high genotypic potential of six cultivars analyzed in the laboratory. However, in the field under adverse variable conditions, the percentage of emergence was different from that observed in the laboratory, which shows that the manifestation of seed vigor can respond directly to environmental influence (Argenta et al., 2003).

In most of the tests performed, the occurrence of local variation was observed between cultivars, fungicide application and interaction fungicide*cultivar. And for testing water content, accelerated aging, electrical conductivity and dry matter, an interaction site*treatment was observed. The variability observed between the two sites for the same cultivar may be due to environmental variations, mainly rainfall occurred prior to harvest in both locations (Figure 1). In all tests applied on the evaluation of the physiological quality, statistical analysis revealed a significant interaction between genotype x fungicide, especially the seeds from Londrina who had the best germination and vigor, highlighting the cultivars IAC 7, IPR AFRODITE and FAEM 6 DILMASUL. Garcia Júnior et al. (2008), in studies with wheat, observed that the use of fungicides in the triazole class does not influence the germination, emergence and speed of seedling emergence. The use of fungicide is a decisive factor in determining the parameters of adaptability and stability for grain yield, justifying, thus, that the application of fungicide may show a favorable effect on increasing phenotypic stability (Lorencetti et al., 2004).

The seeds of cultivar UPFA OURO had lower germination and vigor, possibly influenced by genetic and environmental factors, whereas the other cultivars analyzed under the same conditions are expressed in a superior manner. Thus, it is possible to observe that the interactions of the plant with the environment and the use of fungicide application require further studies, thus enabling to know the range of adaptability and stability of oat genotypes and reduce risks of failure due to the occurrence of adversities of the mean, ensuring the production of seeds of high physiological quality.

Table 7. Mean total seedling length and dry weight of oat seedlings obtained from Londrina – PR (1) and Mauá da Serra - PR (2) in the presence and absence of fungicide application.

Total seedling length (cm)									
			Cultivar						
Site	Mean	Fungicide	IAC 7	URS TAURA	IPR AFRODITE	FAEM 6 DILMASUL	UPF 18	UPFA OURO	Mean
1	22.08 A								
2	16.10 B								
		With	19.61 abA	16.25 cA	20.24 abA	18.76 bA	20.78 aA	19.19 abA	
		Without	20.49 aA	17.60 bA	20.68 aA	17.61 bA	18.82 abB	19. 01 abA	
Dry weight of seedlings (g)									
1	0.29	With							0.28 A
		Without							0.29 A
		Mean	0.27 bc	0.25 c	0.27 bc	0.30 b	0.26 bc	0.38 a	
2	0.32	With							0.32 A
		Without							0.31 A
		Mean	0.24 d	0.30 c	0.27 cd	0.37 b	0.30 c	0.42 a	

Means followed by the same uppercase letter in the column and lowercase in the line, do not differ by Tukey's test at 5% probability. With fungicide (With); Without fungicide (Without).

Conclusions

Grain yield in Mauá da Serra - PR exceeds that of Londrina - PR, Brazil, but the seed quality is lower, although all cultivars have shown germination superior to 90% in the two cultivation sites. Cultivars FAEM 6 DILMASUL and UPFA OURO did not show disease, indicating possible resistance. There is a beneficial effect of product application on germination and vigor, even in the absence of disease.

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