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Physical purity of forage seeds in Brazil

Pureza física de sementes forrageiras no Brasil

Ricardo Miotto Ternus, Geri Eduardo Meneghello, Jerffeson Araujo Cavalcante, Vinícius Jardel Szareski, Ivan Ricardo Carvalho*, Andréa Bicca Noguez Martins, Giordano Gelain Conte and Francisco Amaral Villela

*Departamento de Fitotecnia, Faculdade de Agronomia Eliseu Maciel, Universidade Federal de Pelotas, Pelotas, Rio Grande do Sul, Brazil (*E-mail: carvalho.irc@gmail.com)*

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ABSTRACT

This study aimed to evaluate the physical quality, identify and quantify the contaminants of seeds of forage species in the state of Santa Catarina, Brazil. It was created a data collection with the results obtained from samples of seeds lots collected by the State Inspection Program, from the Input Inspection Division of the State Department of Vegetal Defense, Santa Catarina, Brazil. Batches of ryegrass (*Lolium multiflorum*) seeds (national), black oat (*Avena strigosa*), oat (*Avena sativa*) and Sudan grass (*Sorghum sudanense*) Pers.) commercialized in Santa Catarina among the years 2013 to 2015 presented nonconformities to the presence of other seeds in relation to the Brazilian regulation. Within the lots of forage seeds commercialized in Santa Catarina, only lots of pearl millet (*Setaria italica*) and ryegrass seeds (imported) presented number of other seeds below the legal limit, staying within the commercialization standards, independent of the analyzed year.

Keywords: science and technology of seeds, technical standards, production of seeds.

RESUMO

Este estudo teve o objetivo de avaliar a qualidade física, identificar os contaminantes de sementes de espécies forrageiras e graníferas no estado de Santa Catarina, Brasil. A coleta de dados foi realizada a partir dos resultados obtidos a partir de amostras de lotes de sementes coletadas pelo Programa Estadual de Inspeção, da Divisão de Inspeção de Insumo da Secretaria Estadual de Defesa Vegetal, Santa Catarina, Brasil. Lotes de sementes de azevém (*Lolium multiflorum*) (nacional), aveia preta (*Avena strigosa*), aveia (*Avena sativa*) e capim-sudão (*Sorghum sudanense*) comercializadas em Santa Catarina entre os anos de 2013 a 2015 apresentam não conformidades quanto à presença de outras sementes por número em relação a regulamentação brasileira. Dentro dos lotes de sementes forrageiras comercializadas em Santa Catarina, apenas lotes de sementes de milheto (*Setaria italica*) e azevém (importadas) apresentaram número de outras sementes abaixo do limite legal, mantendo-se dentro dos padrões de comercialização, independente do ano analisado.

Palavras-chave: ciência e tecnologia de sementes, padrões técnicos, produção de sementes.

INTRODUCTION

The quality of a seeds lot is based on the physical, genetic, physiological and phytosanitary quality. Among the aspects, the physical quality of a lot can significantly reduce the productivity of a crop (Vieira & Rava, 2000). It is related to the sanitary quality of a seed lot, impurities, pathogens dissemination, quarantine pests and forbidden dangerous seeds (Vechiato *et al.,* 2010). The presence of pathogens in the seeds results in the decrease of germination and vigor, compromising the development and formation of the crops in the field (Mallmann *et al*., 2013; Marcos Filho, 2015).

The utilization of seeds with proved quality is essential, since the establishment of fields determines the productivity increment (Catão *et al*., 2010). In order to supply the market demand for quality seeds there are intern and extern efforts that maximizes the segments of production chains (Castro *et al*., 2004). To establish the harmony among the production process, commerce and seeds inspection are used parameters that indicate the seeds quality.

It is understood for limit, a percentage or amount above or below the commercialization or technologic proceeding. It is known as pattern, a set of attributes that must be followed by companies in order to be able to put in the market lots of seeds with determined quality (Peske & Meneghello, 2013).

This study aimed to evaluate the physical quality, identify and quantify the contaminants of seeds of forage (ryegrass (*Lolium multiflorum* Lam.), black oat (*Avena strigosa* Schreb.), oat (*Avena sativa* L.), Sudan grass (*Sorghum sudanense* (L.) Pers.) and pearl millet (*Setaria italica* (L.) P. Beauv.)) in the state of Santa Catarina, Brazil.

MATERIAL AND METHODS

The data collection was realized from the results obtained from samples of seeds lots collected by the State Program of Inspection, from the Input Inspection Division (DIFIA), of the State Department of Vegetal Defense (DEDEV), linked to the CIDASC Directory of Agricultural Defense, headquarters in Florianópolis, Santa Catarina, Brazil. It were used samples of forage seeds (ryegrass, black oat, oat, Sudan grass and pearl millet) of different categories, in different municipalities of the state, according to the Service Institution annually published by Plant Health Defense (DEDEV).

The collecting was realized in registered establishments that are randomly inspected. However, all the merchants are inspected in a period inferior to two years. In addition, the service of inspection took in consideration the commercial aptitude of each establishment, which means, the type or frequency of commercialization of each input per period, in order to optimize the collecting procedure. The IS establishes that the sampled lots are the most representative among the exposed to commercialization.

A computerized system makes the management of collected lots and restricts the collecting of two fiscal samples of a same lot. The official collecting is realized within the precepts established by Seed analysis rules (RAS). In the period that goes from the collection to the dispatch to the National Agricultural Laboratory (LANAGRO), the samples are conditioned in craft paper packages and stored in polyethylene box.

The average time foreseen to the sample dispatch to LANAGRO is of 72 hours, counting from the collecting in the commercial establishment. Moreover, from this moment forward, it is waited for analysis result as the species in exam, according with time due foreseen by RAS.

In this manner, based on the BASO (Official seed analysis bulletin), correspondent to the period of 2013 to 2015, it was tabulated the results obtained from the official collecting realized by the inspection, aiming to execute the External Quality Control (CEG) of the state of Santa Catarina. The period chosen was consistent to the beginning of quality control, having as a tool the sample collecting, fruit of the accord firmed with MAPA (Ministry of Agriculture , Livestock and Supply), which, throughout the LANAGRO, located in the city of São José-SC, realized the following analysis:

*Determination of other seeds per number***:** it was realized with the purity analysis, which, from a work sample, as prescribed in the RAS (Brasil, 2009) for

each species, it was verified the number of seeds of other species present in the work sample. It was considered as seeds of other species those that do not belong to the species in analysis, including seeds of other cultivated species, wild and dangerous tolerated.

The data was tabulated in electronic board, were it was calculated the percentage of seeds of other cultivated species, wild and tolerated in lots of forage and grainer seeds. Moreover, it was calculated the frequency of the main species of weed crops present in the seeds lots of the species in study.

RESULTS AND DISCUSSION

In front of the results that will be presented in this study, it is important to highlight that, in all the batches sampled, of all species, national or imported, it was not detected presence of forbidden dangerous seeds, which could put in risk the sanity of the crop cultivation and/or the sanitary vegetal defense of Santa Catarina.

In Table 1 are presented the results of the analysis of seeds samples to the number of seeds of other cultivated species, wild and dangerous tolerated from the lots sampled by the state service of seeds commerce inspection of national and imported ryegrass (*L. multiflorum)* in the state of Santa Catarina, in the period of 2013 to 2015.

In the year of 2013, 75, 95, and 100% of the samples of national ryegrass seeds, corresponding to the number of other cultivated species, wild seeds and dangerous tolerated seeds, respectively, were presented within the legal standards of seeds commercialization. In the same year, the sample of imported ryegrass presented mean conformity percentage above 87% for the criteria number of wild seeds and 100% of conformity for the rest of physical criteria evaluated (Table 1).

Although, in the year of 2014, the average percentage of national ryegrass seeds sample that were within the legal standards, as much for number of other cultivated species as for the number of wild species, was of 97%, considering the samples approved according to the patterns of tolerance established in the chapter 18 of RAS (Brasil, 2009).

In the other hand, for the number of tolerated dangerous seeds the mean conformity was of 88%, highlighting a mean reduction of 12% among the years of 2013 and 2014 (Table 1). However, in relation to the samples of imported ryegrass, there was an increase in the percentage of non-conformity among the sample collected in the year of 2013 in relation to those of 2014, with emphasis to the criteria number of wild seeds, which had an increase of 38% of nonconformity.

The national samples collected in the year of 2015 presented 87 and 97% of mean conformity to the

Table 1 - Quality of seed samples from the Inspection of Seed Commerce of national and imported ryegrass (*Lolium multiflorum* Lam.) in the state of Santa Catarina, in the years of 2013, 2014 and 2015

Ryegrass		Year					
		2013		2014		2015	
		NAC (36) *	IMP (7)	NAC (59)	IMP (11)	NAC (75)	IMP (21)
		%					
Number of other cultivated species	< 5	42	100	71	64	62	100
	6-22	33	-	26	36	25	-
	> 22	25	-	3	-	13	-
Number of wild species	< 5	54	87	71	82	80	100
	6-22	41	-	26	-	17	-
	> 22	5	13	3	18	3	-
Number of dangerous tolerated seeds	< 2	59	100	61	73	26	96
	3-15	41	-	27	27	40	4
	> 15	-	-	12	-	34	-

*number of collected samples in the year.

variables number of other cultivated species and number of wild species, respectively. Still, in the year of 2015, the highest percentage of non-conformity was presented in the variable number of tolerated dangerous, with 34% of batches out of the legal standard for commercialization. In relation to the imported samples collected in the year of 2015, it was observed that they did not present seeds of other cultivated species, wild seeds and neither dangerous tolerated seeds beyond the maximum limit allowed (Table 1).

It is important to emphasize that, with the exception of 2014, it was verified a tendency regarding the 18% of imported lots sampled for the realization of CEQ, being that the participation of imported ryegrass of 16% in 2013 and 2014, leaping to 22% in 2015 (Table 1). There are evidences of the necessity to obtain an efficient production of forage seeds, due to the demand to increment the pasture areas cultivated in the southern region of Brazil.

Species as ryegrass have demonstrated potential to seeds production, however, structural problems, of commercial organization, makes this alternative an expectation in producer level (Garcia e Menezes, 1999). Although, it is necessary to cite that the utilization of legal seeds of diploid ryegrass (national) do not trespass 30% of the total commercialized (Peske, 2016), making that the producer, in most cases, use seeds without quality control (Maia, 1995).

The ryegrass seeds market in the southern Brazil has suffered a decrease in the quality of the offered seeds. The low level of technician in the production fields, in the benefiting, storing, transporting and at commercial establishments that distribute the seeds, has contributed to raise various quality problems of them. In this manner, as the costs of annual pasture implementation are superior to the perennial pasture costs, and it is amortized according to the longevity of the pasture (Carámbula, 1998), each time more producers have looked for seeds with lower market price with the finality to reduce production costs.

This fact has contributed to the illegal commerce of ryegrass seeds. However, the same scenario it is not seen to the imported ryegrass cultivars, since the exporting countries, Uruguay and Argentina, presents efficient certification systems, rigid exporting criteria and fields destined only to seeds production, without other type of secondary activity on the pasture, as example, the integration of the seeds production with livestock.

Among the cultivated species with higher frequency in samples of national ryegrass, it is found *Avena strigosa*, *Bromus catharticus* Vahl. and *Triticum aestivum* L., with frequency varying with 6.6 to 72.2%, independent of the species and collection year. Other species also were identified in the samples throughout the three years evaluated, highlighting *Raphanus sativus* L. and *Avena sativa* (Table 2). Meanwhile, in the imported ryegrass samples, only *A. strigosa* had its frequency related in all evaluated years, being the highest frequency observed in the year of 2014, in 81.8% of sampled lots. Other cultivated species also were observed in the year of 2014, in the imported ryegrass seeds samples, such as *B. catharticus, T. aestivum* and *Festuca arundinacea* Schreb. (Table 2).

In relation to the number of seeds of wild species, present in the seed samples of national ryegrass, only the species *Eleusine indica* (L.) Gaertn. demonstrated frequency in the three analyzed years. Other wild species also were quantified in the seed samples of national ryegrass, as it is the case of *Hypochaeris radicata* L. (19.4%) in 2013, *Silene gallica* L. (23.7%) in 2014, and *Bassia hyssopifolia* (Pall.) Kuntz in the year of 2015 presenting 16% of frequency. In the seed samples of imported ryegrass the amount of wild species was higher than in the national samples, being the *Elymus glaucus* Buckley the most frequent in 2013 with 28.6%, *S. gallica* in the year of 2014 presenting 18.2% of frequency and *Setaria* sp. In 2015 with 4.8% of frequency (Table 2).

In despite of the dangerous tolerated species present in seeds lots of national ryegrass, it was observed that some species presented frequency in the three evaluated years, being, *Echium plantagineum, Raphanus raphanistrum, Solanum* spp. and *Amaranthus* ssp. the species that were present in all analyzed years. Among the most frequent in each year, it is highlighted *E. plantagineum* in the years of 2013 and 2014, with 36.1 and 32.2%, respectively; in the year of 2015, with frequency of 58.6%, it was emphasized the *Piptochaetium montevidense* (Table 2).

Table 2 - Relation and frequency of seeds of other cultivated species, wild and dangerous tolerated present in commercial lots of national and imported ryegrass (*Lolium multiflorum* Lam.) commercialized in the state of Santa Catarina, in 2013, 2014 and 2015

Ryegrass National				**Ryegrass imported**			
Species	Year			Species	Year		
	2013 (36)*	2014 (59)	2015 (75)		2013 (7)	2014 (11)	2015 (21)
Seeds of other cultivated species							
Avena strigosa Schreb.	26/72.2**	31/52.5	54/72.0	*Avena strigosa* Schreb.	1/14.3	9/81.8	1/4,8
Bromus catharticus Vahl.	15/41.6	15/25.5	27/36.0	*Bromus catharticus* Vahl.	-	1/9.1	-
Triticum aestivum L.	16/44.4	5/8.5	5/6.6	*Triticum aestivum* L.	-	1/9.1	-
Raphanus sativus L.	3/8.3	3/5.1	1/1.3	*Festuca arundinacea* Schreb.	-	1/9.1	-
Avena sativa L.	2/5.6	5/8.5	10/13.3	-	-	-	-
Sorghum sudanense (L.) Pers.	5/13.8	-	2/2.6	-	-	-	-
Wild seeds							
Eleusine indica (L.) Gaertn.	15/41.6	1/1.7	16/21.3	*Briza minor* L.	1/14.3	1/9.1	-
Elymus glaucus Buckley	8/22.3	-	3/4.0	*Elymus glaucus* Buckley	2/28.6	-	-
Hypochaeris radicata L.	7/19.4	2/3.4	-	*Eleusine indica* (L.) Gaertn.	1/14.3	1/9.1	-
Iva sp.	-	4/6.8	2/2.6	*Panicum* spp.	1/14.3	-	-
Silene gallica L.	7/19.4	14/23.7	-	*Erica ciliaris* L.	1/14.3	-	-
Bassia hyssopifolia (Pall.) Kuntz	-	-	12/16.0	*Silene gallica* L.	-	2/18.2	-
Veronica arvensis L.	3/8.3	-	8/10.6	*Vulpia* spp.	-	2/18.2	-
Veronica spp.	-	-	6/8.0	*Talinum paniculatum* (Jacq.) Gaertn.	-	2/18.2	-
Avena spp.	-	2/6.8	5/6.6	*Aira caryophyllea* L.	-	-	1/4.8
-	-	-	-	*Setaria italica* (L.) P.Beauv.	-	-	1/4.8
-	-	-	-	*Setaria* sp.	-	2/18.2	1/4.8
-	-	-	-	*Bassia hyssopifolia* (Pall.) Kuntz	-	-	1/4.8
-	-	-	-	*Torilis nodosa* (L.) Gaertn.	-	-	1/4.8
Dangerous tolerated seeds							
Echium plantagineum L.	13/36.1	19/32,2	17/22.6	*Herbetia pulchella* Sweet	-	-	1/4.8
Raphanus raphanistrum L.	10/27.8	10/16.9	5/6.6	*Sinapis arvensis* L.	-	-	1/4.8
Amaranthus sp.	3/8.3	-	-	*Rumex crispus* L.	-	-	1/4.8
Solanum spp.	5/13.9	9/15.3	5/6.6	*Diodia teres* Walt.	-	2/18.2	-
Piptochaetium montevidense (Spreng.) Parodi	11/30.6	8/13.6	44/58.6	*Echium plantagineum* L.	-	3/27.3	-
Plantago virginica L.	-	15/25.5	15/20.0	*Polygonum ramosissimum* Michx.	-	1/9.1	-
Silene gallica L.	-	-	25/33.4	*Cyperus esculentus* L.	-	2/18.2	-
Amaranthus spp.	2/5.6	2/3.4	1/1.3	*Piptochaetium montevidense* (Spreng.) Parodi	1/14.3	2/18.2	-
				Plantago virginica L.	-	4/36.4	-

* number of lots collected per year.** number of lots/frequency of species in lots.

It was observed the presence of *Piptochaetium montevidense* in lots of imported ryegrass seeds in 2013 and 2014. However, in the year of 2014, four dangerous tolerated species were found in lots of imported ryegrass seeds, being *Diodia teres, E. plantagineum, Polygonum ramosissimum* and *Cyperus esculentus* as the species present in these lots. As in the seed lots of national ryegrass in the years 2013 and 2014, the species *Echium plantagineum* was the one that presented higher frequency in seed lots of imported ryegrass in 2014. In 2015, three species were detected in seed batches of imported ryegrass, the *Herbetia pulchella, Sinapis arvensis* and *Rumex crispus*, all presenting 4.8% of frequency (Table 2).

Fernandes *et al.* (2016), evaluating the quality of ryegrass seeds analyzed in the Official Laboratory of Seeds Analysis of the Embrapa Clima Temperado, in the years of 2014, 2015 and 2016, concluded that the seeds used in the southern region of Rio Grande do Sul presented low quality. The main causes for the reproof for commercialization of the analyzed seeds lots were the low purity percentage of samples and the occurrence of seeds of weed species above the allowed. Among the main

weeds, for which occurred amount of seeds above the limits allowed, stood out the *Silene gallica, Hypochaeris spp., Rhynchospora* spp., *Festuca myuros, Briza* sp., *Setaria* sp. *Echium plantagenium*, *Piptochaetium montevidense*, *Rumex* sp., *Plantago* sp. and *Cyperus* sp.

In relation to the black oat seeds lots inspected from 2013 to 2015, it was observed that for the number of cultivated species, there was a reduction in the number of nonconformities from 97% in 2013 to 95% in 2015, demonstrating a low reduction of this criterion within years. Although, it is perceived that the amount of non-conformities it is found elevated, independent of the reduction of the number of reproof within the evaluated years (Table 3).

For the number of wild seeds present in the black oat seed lots it was verified, in the year of 2013, that 100% of the batches were presented within the commercialization standards. In the years of 2014 and 2015, 13 to 15% of the lots, respectively, presented wild seeds above the allowed for commercialization (Table 3). In 2013, 50% of the evaluated batches presented non-conformity in the number of dangerous tolerated seeds. However, in the years of 2014 and 2015, it was possible to observe considerable reduction in the number of nonconformities related to dangerous tolerated species present in black oat seeds lots, being 25% in 2014 and 30% in 2015.

For oat seeds, it was observed that 72% of the inspected lots in the year of 2013 were presented out of the standards in relation to number of other cultivated species. In 2014, there was reduction of 12% of non-conformity in relation to 2013 for the same variable, however, in 2015, 71% of the samples were out of minimum legal standards for other cultivated species. In this context, it is important to highlight that, considering the criteria established by the tolerance standards proposed by RAS, the percentage of approved lots of oat seeds in the period

Table 3 - Quality of seed samples originated from the Inspection of Seeds Commerce of black oat (*Avena strigosa* Schreb.) in the state of Santa Catarina, in 2013, 2014 and 2015

Black oat		**Year**		
		2013 (32)*	**2014 (40)**	**2015 (134)**
		%		
Number of other cultivated species	<6	-	-	1
	6-20	3	4	4
	>20	97	96	95
Number of wild species	<6	97	80	60
	6-20	3	7	25
	>20	-	13	15
Number of dangerous tolerated seeds	<3	37	60	51
	3-6	13	15	19
	>6	50	25	30
Oat		**Year**		
		2013 (7)*	**2014 (10)**	**2015 (24)**
			%	
Number of other cultivated species	<8	28	30	21
	8-13	-	10	8
	>13	72	60	71
Number of wild species	<5	100	100	92
	5-9		-	4
	>9		-	4
Number of dangerous tolerated seeds	<3	58	50	63
	3-6		30	21
	>6		20	16

* number of collected samples in the year.

(2013-2015) was 28, 40 and 29%, respectively, for the criterion number of seeds of other cultivated species (Table 4).

In relation to the number of wild seeds in lots of oat seeds, it was possible to observe that, in 2013 and 2014, 100% of the lots presented conformity for this variable. However, only 4% of the inspected batches, in 2015, presented wild seeds above the allowed by legislation (Table 4), being this one of the criteria that proportionate problems in inspected oat lots. When it was evaluated the number of dangerous tolerated seeds, it was observed that, in 2013, 28% of the inspected lots were approved, though, there was reduction in the number of reproof lots within the years, being 20% for 2014 and 16% for 2015, demonstrating 12% reduction within 2013 to 2015.

The low quality standards of national ryegrass seeds, black oat and oat, the lack of demand for high quality seeds, the reduced offer of basic seeds, the production technology, and sometimes, the uncertainties, resulted in a commerce characterized by seeds of low physical and varietal purity, low viability and high contamination by invasive crop seeds. Seeds with such characteristics were, probably, responsible for many failures in the pasture formation within the years (Souza, 1984).

Table 4 - Relation and frequency of seeds of other cultivated species, wild and dangerous tolerated present in commercial lots of black oat (*Avena strigosa* Schreb.) and oat (*Avena sativa* L.) commercialized in the state of Santa Catarina, in 2013, 2014 and 2015

Black oat				**Oat**			
Species	Year			Species	Year		
	2013 (32)*	2014 (40)	2015 (134)		2013 (7)	2014 (10)	2015 (24)
Seeds of other cultivated species							
Lolium multiflorum Lam.	31/96.9**	34/85.0	129/96.3	*Avena strigosa* Schreb.	6/85.7	4/40.0	22/91.7
Bromus catharticus Vahl.	12/37.5	16/40.0	64/47.8	*Bromus catharticus* Vahl.	1/14.3	-	4/16.7
Triticum aestivum L.	30/93.8	37/92.5	129/96.3	*Triticum aestivum* L.	6/85.7	-	22/91.7
Raphanus sativus L.	4/12.5	9/10.7	27/20.1	*Sorghum sudanense* (L.) Pers.	1/14.3	4/40.0	10/41.6
Avena sativa L.	29/90.6	37/92.5	126/94.0	*Lolium multiflorum* Lam.	3/42.9	1/10.0	14/58.3
Pennicetum glaucum (L.) R. Br.	5/13.9	11/27.5	15/11.2	*Hordeum vulgare* L.	-	-	5/20.8
Vicia sativa L.	14/16.7	14/35.0	-	*Panicum maximum* Jacq.	-	1/10.0	-
-	-	-	-	*Sorghum bicolor* (L.) Moench	-	-	1/4.2
Wild seeds							
Panicum maximum Jacq.	1/3.1	-	16/11.9	Fabaceae species	1/14.3	-	-
Fabaceae species	3/9.4	-	-	*Talinum paniculatum* (Jacq.) Gaertn.	-	-	1/4.2
Brachiaria plantaginea	1/3.1	-	-	*Avena* spp.	-	2/20.0	10/41.7
Caryophyllaceae	1/3.1	2/5.0	-	-	-	-	-
Avena spp.	-	22/55.0	88/65.6	-	-	-	-
Brassica spp.	-	2/5.0	12/8.9	-.	-	-	-
Juncus spp.	-	1/4.0	1/0.7	-	-	-	-
Veronica spp.	-	1/4.0	2/1.5	-	-	-	-
Dangerous tolerated seeds							
E. plantagineum L.	4/12.5	9/22.5	15/11.1	*R. raphanistrum* L.	1/14.3	-	3/12.5
R. raphanistrum L.	9/28.1	11/27.5	32/23.8	*Avena barbata* Pott ex Link.	2/28.6	6/60.0	7/29.2
Avena fatua L.	8/25.0	38/95.0	23/17.1	*Cenchrus echinatus* L.	1/14.3	-	1/4.2
Sinapis arvensis L.	5/15.6	2/5.0	5/3.7	*Sinpis arvensis* L.	1/14.3	2/20.0	-
Avena barbata Pott ex Link.	-	23/57.5	41/30.5	*Avena fatua* L.	-	4/40.0	5/20.8
Fallopia convolvulus (L.) Á. Löve	4/12.5	8/20.0	15/11.1	*Fallopia convolvulus* (L.) Á. Löve	-	1/10.0	1/4.2
-	-	-	-	*Ipomea triloba* L.	-	-	1/4.2
-	-	-	-	*Sida* sp.	-	-	2/8.3

* number of lots collected per year.** number of lots/frequency of species in lots.

Among the cultivated species that presented higher frequency in the lots of black oat seeds for the three analyzed years, stood out *Lolium multiflorum, Bromus catharticus, Triticum aestivum, Raphanus sativus, Avena sativa* and *Pennisetum glaucum*, and within all the cultivated species, stood out *Triticum aestivum* and *Avena sativa*, both with frequency superior to 90% in all analyzed years (Table 5). For the oat seed lots, only three species presented frequency in all years, *Avena strigosa, Sorghum sudanense* and *Lolium multiflorum*. However, it is worth to emphasize that the high frequencies observed for *Triticum aestivum* in 2013 and 2015, with frequency of 85.7 and 91.7%, respectively (Table 5).

In relation to wild seeds, nine species presented frequency inferior to 10% in three years, for lots of black oat. The species that presented higher frequency in lots of black oat seeds were from the genus *Avena*, in the years 2014 and 2015. For oat, it was observed only one wild species (*Talinum paniculatum*) in the inspected lots in 2015, with 4.2% of frequency. Other *Avena* species and seeds of Fabaceae family also were verified during the study but it was impossible to identify the species seeds of this plant family (Table 5).

In relation to the number of dangerous tolerated species, it was observed for black oat, that the species *Echium plantagineum, Raphanus raphanistrum, Avena fatua, Sinapis arvensis* and *Fallopia convolvulus* presented frequency in the three evaluated years, being, on average, *Raphanus raphanistrum* and *Avena fatua* the most frequent. Moreover, in this lots it was verified the presence of *Avena barbata* in the years 2014 and 2015. Although, for oat, only *Avena barbata* was found in three years, however, species as *Raphanus raphanistrum, Cenchrus echinatus, Sinapis arvensis, Avena fatua, Fallopia convolvulus, Ipomoea triloba* and *Sida* sp. were also detected in the inspection. Within the last cited species, *Avena* presented the higher mean frequency in lots of oat seeds, independent of the analyzed year (Table 5).

Considering the evaluated forage, the lots of millet seeds were the ones that presented lower number of non-conformities in relation to the number of seeds of other cultivated species, wild seeds and dangerous tolerates (Table 6). In 2013 it was verified that 6% of the evaluated lots for number of dangerous tolerated seeds were out of the quality standards. Although, in 2015 it was verified non-conformity only for number of other cultivated species, with 1% of millet seeds lots out of standards (Table 6). In 2013, it was verified that 6% of the evaluated lots for number of dangerous tolerated seeds were out of quality standards, since in 2014 was observed 2% of non-conformity for the same variable. In 2015, it was verified non-conformity only for number of other cultivated species, with 1% of millet seeds lots out of standards (Table 6).

The low number of non-conformity in lots of millet seeds, in comparison to other forage species, in relation to the number of seeds of other cultivated species, wild seeds and dangerous tolerated seeds, can be attributed to more audacious productive aspects, boosted by a sector that enforces the seeds quality in detriment of the market price.

Table 5 - Quality of seeds samples originated from the Inspection of Seed Commerce of Sudan grass (*Sorghum sudanense* (L.) Pers and millet (*Setaria italica*. (L.) P. Beauv.) in the state of Santa Catarina, in 2013, 2014 and 2015

Sudangrass		**Year**		
		2013 (61)*	**2014 (143)**	**2015 (107)**
		%		
Number of other cultivated species	<30	52	72	74
	30-73	13	13	13
	>73	35	15	13
Number of wild species	<30	94	96	96
	30-73	3	4	1
	>73	3	-	3
Number of dangerous tolerated seeds	<10	74	70	85
	10-22	8	8	8
	> 22	18	22	7
Millet		**Year**		
		2013 (48)	**2014 (53)**	**2015 (86)**
		%		
Number of other cultivated species	<30	98	100	96
	30-39	2	-	3
	>39	-	-	1
Number of wild species	<40	94	94	100
	40-51	-	-	-
	> 51	6	6	-
Number of dangerous tolerated seeds	<50	94	98	100
	50-62	-	-	-
	> 62	6	2	-

* number of lots collected per year.

In a similar study, Ohlson *et al*. (2010) realized a data collection about the physical quality of millet seeds lots commercialized in the state of Paraná, in the crop seasons of 2006, 2007 and 2008.

It was observed that the most of millet samples analyzed in three studied seasons presented within the seed commercialization standard for the species in relation to the percentage of pure seeds, and 25% of the seed samples of de cultivar BN2, in 2006, and 100% of the seed samples of the cultivar BRS 1501, in 2007, were below the commercialization standard for this parameter.

Within the cultivated species in Sudan grass seeds lots, with frequency in the three evaluated years, stood out *Lolium multiflorum, Sorghum bicolor, Crotalaria spectabilis* and *Avena strigosa*. Yet and *Pennisetum glaucum* presented higher frequency in the years 2013 and 2014, with 86.8 and 71.3%, respectively, and in 2015, the species that presented higher frequency was *Trifolium pretense* with 15.7% (Table 6). However, for millet seed lots, only one cultivated specie presented frequency in three consecutive years (*Lolium multiflorum*) (Table 6). In the other hand, some species as *Avena strigosa, Crotalaria juncea* and *Sorghum sudanense* presented frequency of seeds in the millet lots, at least, in two

Table 6 - Relation and frequency of seeds of other cultivated species, wild and dangerous tolerated present in commercial lots of Sudan grass (*Sorghum sudanense* (L.) Pers.) and millet (*Setaria italica* (L.) P. Beauv.) seeds commercialized in the state of Santa Catarina, in 2013, 2014 and 2015

Sudan grass				**Millet**			
Species	Year			Species	Year		
	2013b (61)*	2014b (143)	2015 (108)		2013 (48)	2014 (53)	2015B (92)
Seeds of other cultivated species							
Lolium multiflorum Lam.	7/11.4**	8/5.6	2/1.8	*Avena strigosa* Schreb.	-	1/1.8	22/23.9
Sorghum bicolor (L.) Moench	4/6.5	26/18.2	14/12.9	*Crotalaria juncea* L.	1/2.1	-	4/4.3
Crotalaria spectabilis Roth.	7/11.4	15/10.5	1/0.9	*Triticum aestivum* L.	-	-	22/23.9
Avena strigosa Schreb.	6/9.8	5/3.5	6/5.6	*Sorghum sudanense* (L.) Pers.	18/37.5	21/39.6	-
Pennicetum glaucum (L.) R. Br.	53/86.8	102/71.3	-	*Lolium multiflorum* Lam.	2/4.2	1/1.8	14/15.2
Triticum aestivum L.	2/3.2	16/11.2	-	*Hordeum vulgare* L.	-	-	5/5.4
Trifolium pratense L.	-	-	17/15.7	*Panicum maximum* Jacq.	-	1/1.8	
Panicum maximum Jacq.	2/3.2	-	8/7.4	*Sorghum bicolor* (L.) Moench	-	-	
Wild seeds							
Eleusine indica (L.) Gaertn.	2/3.2	5/3.5	1/0.9	*Digitaria ciliaris* (Retz.) Koeler	14/29.2	19/35.8	8/8.7
Setaria sp.	-	2/1.4	-	*Digitaria sanguinalis* (L.) Scop.	12/25.0	-	-
Digitaria ciliaris (Retz.) Koeler	-	56/39.2	16/14.8	*Eleusine indica* (L.) Gaertn.	5/10.4	-	2/2.2
Panicum virgatum L.	3/4.9	-	-	*Panicum virgatum* L.	4/8.3	1/1.8	-
Caryophyllaceae species	-	-	1/0.9	*Bidens pilosa* L.	1/2.1	2/3.7	-
Panicum sp.	-	4/2.8	-	*Commelina* sp.	-	2/3.7	2/2.2
Panicum dichotomiflorum Michx.	1/1.6	-	1/0.9				
Desmodium spp.	-	-	1/0.9				
Dangerous tolerated seeds							
Senna obtusifolia (L.)H.S.Irwin & Barneby.	13/21.3	24/16.8	13/12.0	*Euphorbia heterophylla* L.	23/47.9	11/20.7	18/19.6
Sida rhombifolia L.	7/11.4	-	-	*Ipomea triloba* L.	9/18.8	12/22.6	-
Crotolaria benghalensis Lam.	8/13.1	-	-	*Digitaria insularis* (L.) Fedde.	5/10.4	-	-
Euphorbia heterophylla L.	15/24.6	41/28.8	16/14.8	*Cyperus esculentus* L.	3/6.3	-	-
Ipomea triloba L.	8/11.4	19/13.2	-	*Senna obtusifolia* (L.)H.S.Irwin & Barneby.	6/12.5	4/7.5	1/1.1
Ipomoea spp.	2/3.2	24/16.8	10/9.2	*Ipomoea* spp.	1/2.1	6/11.3	18/19.6
Cenchrus echinatus L.	-	55/38.5	30/27.8	*Sida rhombifolia* L.	3/6.3	1/1.8	2/2.2
Raphanus raphanistrum L.	3/4.9	13/9.1	9/8.3	*Ipomoea* sp.	-	2/3.7	15/16.3

* number of lots collected per year. ** number of lots/frequency of species in lots.

years. Considering the higher frequencies in lots of millet seeds, it was verified that for both cultivated species *Triticum aestivum* and *Avena strigosa*, in 2015, appeared with 23.9%. Although, *Sorghum sudanense* presented higher mean frequency for the years 2013 and 2014 with 38.5%.

In relation to the number of wild seeds present in lots of Sudan grass seeds, only *Eleusine indica* seeds were found in all crop seasons, with frequency inferior to 4%. Although, the higher frequencies of wild species in Sudan grass lots was *Digitaria ciliaris*, which were observed in 2014 and 2015, with 39.2 and 14.8%, respectively (Table 6). In lots of millet, as in 2014 and 2015 years of Sudan grass, the species most frequent was *Digitaria ciliaris*, although, emphasizing in all evaluated years, with mean frequency of 24.5% (Table 6).

When it was evaluated the number of dangerous tolerated species, it was verified as much for lots of Sudan grass seeds as for millet, independent of the year in which they were collected the samples for inspection, that *Euphorbia heterophylla* was presented with higher frequency. Dangerous tolerated species as *Ipomoea triloba* and other species of the *Ipomoea* genus also presented high frequency in lots of Sudan grass and millet seeds (Table 6).

Ohlson *et al.* (2010), when evaluating the number of seeds of other cultivated species, number of wild species and number of dangerous tolerated species of millet seed lots commercialized in the state of Paraná, in the crop seasons of 2006, 2007 and 2008, observed that only for number of dangerous tolerated seeds was verified irregular lots of millet seeds, independent of the season. The most frequent species and above the maximum allowed number were: *Cyperus* spp., *Digitaria ciliaris*, *Euphorbia* spp., *Sida* spp., *Ipomoea* spp., *Echinochloa colonum* and *Echinochloa crus-galli*. These species also were found in this study, possible demonstrating difficulties in the conduction of production fields, as well in the separation during the benefiting of millet seeds, even if considering seven years of difference between studies.

In this scenario, it is possible to verify that, the non-conformities verified in lots of forage species, related to the presence of other seeds per number, and presented distinct behavior. In winter forage, the presence of seeds of other cultivated species, wild seeds and dangerous tolerated seeds followed the same pattern of non-conformity within the analyzed period, demonstrating the inertia of the productive sector in responding the failures detected by CEQ. In the other hand, in lots of summer forage species, it was possible to verify a graduate increase in the seeds quality. It is worth to accentuate the difficulties, as much in the productive process as in the benefiting of forage seeds, however, it has to be considered that technologies to obtain high quality seeds of these species exists, since the high percentage of conformity of imported seed lots analyzed in this study. This result is an indicative which demonstrate that the investment in technology and capable labor reflect directly in high quality seeds.

CONCLUSIONS

Batches of ryegrass seeds (national), black oat, oat and Sudan grass commercialized in Santa Catarina among the years 2013 to 2015 present non-conformities in relation to the presence of other seeds per number.

Within the lots of forage seeds commercialized in Santa Catarina, only lots of millet and ryegrass (imported) seeds presented number of other seeds below the legal limit, staying within the commercialization standards, independent of the analyzed year.

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