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Sampling Intensity in Wheat and Rice Seed Lots

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Abstract

Wheat and rice have high economic and food importance, making the use of seeds with proven physical and physiological quality essential. This study aimed to evaluate whether reducing sampling intensity changes the results of mandatory and complementary analyses used in the seed certification system. Sampling was performed in big bags from commercial wheat and rice seed lots, using four collection intensities corresponding to 100, 75, 50 and 25% of the recommended number of primary samples. The samples were analyzed at the Flávio Farias da Rocha Seed Laboratory, Federal University of Pelotas, for physical purity, determination of other seeds, inert material, germination and viability by the tetrazolium test. The results were compared based on the tolerances established in the Rules for Seed Testing, at 5% probability. No significant differences were observed among the evaluated intensities for the studied lots and cultivars. Thus, under the conditions of this study, sampling intensity could be reduced to 25% without impairing the interpretation of laboratory results.

Keywords: certification; germination; physical purity; physiological quality; tetrazolium

1. Introduction

Wheat and rice occupy a prominent position in the Brazilian agricultural scenario, due to their high demand and importance for human and animal food. Rice is a staple food for a significant portion of the population, while wheat is widely used in the production of flour, food products, and feed, especially in production systems in the southern region of Brazil [1] (p. 9), [2] (p. 8).

Rice production has economic and social relevance, being destined for domestic supply, the formation of stocks, industry and export. In Brazil, production is mainly concentrated in the states of the South Region, especially Rio Grande do Sul and Santa Catarina, which account for a large part of the national production and Mercosur [2] (p. 9).

Wheat, in turn, is the main winter crop in the country, although national production still does not fully meet domestic demand. This scenario reinforces the n0065ed for strategies that contribute to increasing production efficiency, among which the use of seeds with high physical, physiological, and sanitary quality stands out [3] (p. 8).

Seed quality is one of the determining factors for the proper establishment of crops, as seeds with high germination, vigor and purity favor the uniformity of emergence and the initial performance of the plants. In addition, sanitary quality and the correct identification of lots contribute to reducing the risks of pathogen dissemination and varietal mixture, which are relevant aspects for the production and commercialization of seeds [4] (p. 8); [5] (p. 9); [6] (p. 5); [7] (p. 6); [8] (p. 5) and [9] (p. 9).

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In this context, seed certification plays a fundamental role in ensuring genetic identity, traceability and quality of propagative material. Sampling represents an essential step in this process, as the reliability of laboratory results depends on obtaining representative samples of the batch. Thus, the sample must contain the components of the batch in proportions like their occurrence, allowing the analyses to express the real quality of the material evaluated [10] (p. 9).

The sampling intensity recommended by the official standards seeks to reduce errors resulting from the heterogeneity of the lots. However, in processed, homogeneous batches stored in large packages, such as big bags, the increase in the number of simple samples can increase operational time and collection costs. On the other hand, inadequate reductions in sampling intensity can compromise representativeness and generate incorrect interpretations about the quality of the lot.

Therefore, the present work aimed to evaluate the possibility of reducing the sampling intensity in wheat and rice seed lots, verifying its effects on the results of physical purity, determination of other seeds, inert material, germination and tetrazolium.

2. Materials and Methods

The study was conducted from September 2024 to May 2025 and comprised two stages. The first stage consisted of sampling commercial wheat and rice seed lots from seed producers associated with the Pro Sementes Foundation in the city of Passo Fundo and the Campanha and Northwest regions of the state of Rio Grande do Sul, Brazil. The second stage involved laboratory analyses performed at the Flávio Farias da Rocha Seed Analysis Laboratory of the Eliseu Maciel Faculty of Agronomy, Federal University of Pelotas, in Capão do Leão, Rio Grande do Sul, Brazil.

2.1. Experimental Design and Experimental Unit

The study was structured to evaluate the effect of reduced sampling intensity on seed quality analysis results. The experimental unit was the seed lot, and the factor evaluated was sampling intensity, defined by the number of simple samples collected directly from each lot.

Four sampling intensities were evaluated: 40 simple samples, corresponding to 100% of the reference sampling intensity; 30 simple samples, corresponding to 75%; 20 simple samples, corresponding to 50%; and 10 simple samples, corresponding to 25%.

Each sampling intensity was applied once to each lot, with no replication of the sampling procedure. Therefore, the 40, 30, 20, and 10 units collected did not constitute experimental replicates but represented different levels of the sampling-intensity factor. The simple samples collected at each intensity were combined to form a single composite sample, which was subsequently used to prepare the samples for laboratory analyses.

Replications were used exclusively in laboratory tests for which replicated analytical units were established, as described in the respective procedures.

2.2. Seed Lot Sampling

Seed lots of wheat cultivars BRS Tarumaxi and ORS Guardião and rice cultivars IRGA 424 RI, Pampeiro, Guri INTA CL, and IRGA 431 CL, from the 2023/2024 harvest, were evaluated. The lots were stored in 1000-kg big bags.

Sampling was performed using a Nobbe-type sampler, following the procedures established by the Brazilian Rules for Seed Testing (RAS) [10]. The Nobbe-type sampler is a tubular device designed for collecting seed samples from packages, with a lateral opening that allows seeds to enter the sampler during collection. It is manufactured from

304 stainless steel, in accordance with official technical standards (such as RAS and the MAPA Normative Instruction).

For sampling, the sampler was inserted into the central region of the big bag, with the opening facing downward and the tip directed upward at an angle of approximately 30° relative to the horizontal. The sampler was then rotated 180°, positioning the opening upward, and slowly withdrawn, allowing seeds to enter progressively along the withdrawal path.

The central sampling position and the sampler operating procedure were kept constant for all sampling intensities. Thus, the sampling position was not considered an experimental factor, and the only factor evaluated was the number of simple samples collected directly from each lot.

Sampling intensities were defined according to the number of simple samples collected from each lot: 40 simple samples, corresponding to 100% of the reference intensity; 30 simple samples, corresponding to 75%; 20 simple samples, corresponding to 50%; and 10 simple samples, corresponding to 25%.

After collection, the simple samples corresponding to each intensity were combined to form a single composite sample.

2.3. Sample Preparation

The composite samples were homogenized and subjected to three successive passes through a sample divider to ensure uniform seed distribution and reduce the sample quantity until a 1000-g laboratory sample was obtained.

The laboratory samples were placed in properly identified containers and transported to the Flávio Farias da Rocha Seed Analysis Laboratory. At the laboratory, each 1000-g sample was homogenized again and passed through the sample divider to obtain a 500-g working sample.

The sample preparation sequence was therefore: simple samples → composite sample → homogenization → three successive passes through the sample divider → 1000-g laboratory sample → homogenization and further subdivision → 500-g working sample.

The 500-g working sample was used in its entirety for the physical purity analysis. For the germination and tetrazolium tests, the number of seeds specified in the respective RAS procedures [10] was used.

2.4. Physical Purity Analysis and Determination of Other Seeds

Physical purity analysis was performed using the entire 500-g working sample, according to the procedures established by the RAS [10]. The sample was separated into pure seeds, inert matter, and other seeds. After separation, the components were identified and weighed, and the results were expressed as a percentage of the total sample mass.

The determination of other seeds was performed by manually identifying and counting the seeds present in the sample, following the procedures established by the RAS [10].

2.5. Germination Test

The germination test was performed using 400 seeds per sample, distributed into four replicates of 100 seeds. The seeds were placed on paper moistened with distilled water at a volume equivalent to 2.5 times the dry paper weight.

The tests were conducted in germinators at 25 °C for rice and 20 °C for wheat. Evaluations were performed according to the periods and procedures established by the RAS [11], and the results were expressed as the percentage of normal seedlings.

Normal seedlings were defined as those exhibiting adequate development of the essential structures and the capacity to continue development under favorable conditions, according to the morphological criteria established by the RAS [11].

The four replicates of 100 seeds constituted analytical replicates of the germination test and did not represent replications of the seed lot sampling procedure.

2.6. Tetrazolium Test

The tetrazolium test was performed using 100 seeds per sample, distributed into two replicates of 50 seeds. The seeds were soaked for 18 h in a biological oxygen demand (BOD) chamber at 20 °C for wheat and 25 °C for rice.

Before soaking, rice seeds were dehulled using a zaccaria equipment for 5 min. After soaking, the seeds were longitudinally sectioned to expose the embryo and subsequently immersed in 50 mL of a 0.5% solution of 2,3,5-triphenyl tetrazolium chloride.

Staining was performed in a BOD chamber in the dark at 30 °C for 4 h. After staining, the seeds were washed under running water and evaluated for viability using a stereoscopic microscope.

Seeds were considered viable when they exhibited a staining pattern compatible with the maintenance of embryo viability and essential tissues, according to the criteria established by the RAS [10]. The results were expressed as the percentage of viable seeds.

The two replicates of 50 seeds constituted analytical replicates of the tetrazolium test and did not represent replications of the seed lot sampling procedure.

2.7. Comparison Among Sampling Intensities

The results obtained with 30, 20, and 10 simple samples were compared with those obtained using the reference intensity of 40 simple samples (100%).

For this comparison, the tolerance tables established by the RAS for germination, the tetrazolium test, determination of other seeds by number, and verification of other cultivars were used [10].

For tests involving analytical replicates, the mean values of the respective replicates were calculated. Subsequently, the results obtained with the reduced sampling intensities were compared with those obtained using the reference intensity, based on the corresponding tolerance values established by the RAS.

The observed differences were evaluated against the corresponding tolerance values, considering a 5% probability level. When the difference between the results did not exceed the tolerance value established by the RAS, the results were within the acceptable tolerance limits.

Thus, the study evaluated whether reducing the number of simple samples collected directly from the seed lots, from 40 to 30, 20, or 10, allowed seed quality results to be obtained within the tolerance limits established by the RAS.

3. Results

3.1. Characterization of the Seed Lots

The initial characterization of the wheat seed lots showed high physical and physiological quality. For BRS Tarumaxi, the reference sampling intensity (A40) resulted in physical purity values ranging from 99.9 to 100.0%, germination from 96 to 98%, and tetrazolium viability from 93 to 97% among the four evaluated lots (Tables 1 and 2). For ORS Guardião, physical purity ranged from 99.7 to 100.0%, germination from 91 to 94%, and tetrazolium viability from 92 to 94%.

Table 1. Physical purity and determination of other seeds and inert material in wheat seed lots of the cultivars BRS Tarumaxi and ORS Guardião under different sampling intensities. Capão do Leão, RS, Brazil, 2025.

Tests	Cultivars	Lots	A40	A30	A20	A10
Purity (%)	BRS Tarumaxi	L1	99.9	99.8 ns	99.8 ns	99.5 ns
		L2	100.0	99.6 ns	99.7 ns	99.6 ns
		L3	99.9	99.7 ns	99.8 ns	99.7 ns
		L4	100.0	99.6 ns	99.6 ns	99.8 ns
	ORS Guardião	L1	99.8	99.6 ns	99.6 ns	100.0 ns
		L2	99.9	100.0 ns	99.8 ns	99.8 ns
		L3	100.0	99.7 ns	100.0 ns	99.8 ns
		L4	99.7	99.7 ns	99.7 ns	99.9 ns
D.O.S./M.I. (%)	BRS Tarumaxi	L1–L4	0.0	0.0 ns	0.0 ns	0.0 ns
	ORS Guardião	L1–L4	0.0	0.0 ns	0.0 ns	0.0 ns

ns: does not differ significantly from the sampling intensity indicated in the RAS (A40). D.O.S./M.I.: determination of other seeds/inert material.

Table 2. Different sampling intensities and germination and tetrazolium in wheat seeds of the cultivars BRS Tarumaxi and ORS Guardião. Capão do Leão, 2025.

Tests	Cultivars	Lots	A40	A30	A20	A10
Germ (%)	BRS Tarumaxi	L1	97	96 ns	95 ns	94 ns
		L2	98	98 ns	95 ns	95 ns
		L3	96	96 ns	92 ns	91 ns
		L4	97	97 ns	96 ns	96 ns
	ORS Guardião	L1	91	90 ns	91 ns	91 ns
		L2	92	94 ns	92 ns	90 ns
		L3	93	92 ns	93 ns	91 ns
		L4	94	93 ns	92 ns	92 ns
Tetrazolium (%)	BRS Tarumaxi	L1	96	95 ns	93 ns	92 ns
		L2	97	98 ns	99 ns	94 ns
		L3	95	94 ns	93 ns	93 ns
		L4	93	94 ns	92 ns	91 ns
	ORS Guardião	L1	92	92 ns	91 ns	91 ns
		L2	94	95 ns	94 ns	92 ns
		L3	94	94 ns	93 ns	90 ns
		L4	93	92 ns	90 ns	91 ns

ns: does not differ significantly from the sampling intensity indicated in the RAS (A40). Germ: germination; Users: tetrazolium.

No other seeds were detected in any of the wheat seed lots evaluated. Inert material was also 0.0% in all wheat lots and sampling intensities (Table 1).

For rice, the seed lots also showed high physical and physiological quality. Under reference sampling intensity (A40), physical purity ranged from 99.7 to 100.0% for IRGA

424 RI, from 99.8 to 100.0% for Pampeiro, from 99.8 to 100.0% for Guri INTA CL, and from 99.9 to 100.0% for IRGA 431 CL (Table 3). Germination ranged from 92 to 94%, 95 to 97%, 95 to 97%, and 93 to 95%, respectively (Table 4). Tetrazolium viability ranged from 97 to 98% for IRGA 424 RI, 93 to 95% for Pampeiro, 96 to 98% for Guri INTA CL, and 93 to 95% for IRGA 431 CL (Table 5).

Table 3. Different sampling intensities and purity percentages, in rice seeds of the cultivars IRGA 424 RI, Pampeiro, Guri INTA CL and IRGA 431 CL. Capão do Leão, 2025.

Cultivars	Lots	A40	A30	A20	A10
IRGA 424 RI	L1	99.8	99.8 ns	99.9 ns	100.0 ns
	L2	99.7	100.0 ns	99.8 ns	99.8 ns
	L3	100.0	99.8 ns	100.0 ns	99.8 ns
	L4	99.8	99.7 ns	99.9 ns	99.7 ns
PAMPEIRO	L1	99.8	99.9 ns	99.8 ns	99.6 ns
	L2	100.0	99.8 ns	99.9 ns	99.8 ns
	L3	99.8	99.8 ns	99.8 ns	99.9 ns
	L4	100.0	99.6 ns	99.7 ns	99.8 ns
GURI INTA CL	L1	99.8	100.0 ns	99.8 ns	99.9 ns
	L2	100.0	99.8 ns	100.0 ns	99.8 ns
	L3	99.8	99.8 ns	99.8 ns	100.0 ns
	L4	100.0	99.7 ns	99.7 ns	99.8 ns
IRGA 431 CL	L1	99.8	99.8 ns	99.9 ns	100.0 ns
	L2	99.9	100.0 ns	99.8 ns	99.8 ns
	L3	100.0	99.8 ns	100.0 ns	99.8 ns
	L4	99.9	99.7 ns	99.9 ns	99.7 ns

ns: does not differ significantly from the sampling intensity indicated in the RAS (A40).

Table 4. Different sampling intensities and germination in rice seeds of the cultivars IRGA 424 RI, Pampeiro, Guri INTA CL and IRGA 431 CL. Capão do Leão, 2025.

Cultivars	Lots	A40	A30	A20	A10
IRGA 424 RI	L1	92	92 ns	91 ns	91 ns
	L2	94	95 ns	94 ns	92 ns
	L3	94	94 ns	93 ns	90 ns
	L4	93	92 ns	90 ns	91 ns
PAMPEIRO	L1	95	94 ns	94 ns	92 ns
	L2	96	94 ns	95 ns	95 ns
	L3	97	96 ns	95 ns	94 ns
	L4	96	97 ns	95 ns	95 ns

Table 4. *Cont.*

Cultivars	Lots	A40	A30	A20	A10
GURI INTA CL	L1	95	97 ns	94 ns	91 ns
	L2	95	94 ns	94 ns	92 ns
	L3	96	94 ns	95 ns	95 ns
	L4	97	96 ns	95 ns	94 ns
IRGA 431 CL	L1	94	96 ns	92 ns	91 ns
	L2	95	97 ns	94 ns	91 ns
	L3	93	92 ns	92 ns	90 ns
	L4	93	94 ns	92 ns	92 ns

ns: does not differ significantly from the sampling intensity indicated in the RAS (A40). Germ: germination. Source.

Table 5. Different sampling intensities and tetrazolium in rice seeds of the cultivars IRGA 424 RI, Pampeiro, Guri INTA CL and IRGA 431 CL. Capão do Leão, 2025.

Cultivars	Lots	A40	A30	A20	A10
IRGA 424 RI	L1	97	96 ns	96 ns	97 ns
	L2	98	98 ns	95 ns	96 ns
	L3	97	96 ns	96 ns	97 ns
	L4	98	98 ns	97 ns	96 ns
PAMPEIRO	L1	95	94 ns	93 ns	93 ns
	L2	93	94 ns	92 ns	91 ns
	L3	94	92 ns	91 ns	90 ns
	L4	93	94 ns	93 ns	91 ns
GURI INTA CL	L1	98	97 ns	96 ns	94 ns
	L2	96	95 ns	93 ns	92 ns
	L3	97	98 ns	99 ns	94 ns
	L4	98	98 ns	97 ns	96 ns
IRGA 431 CL	L1	95	94 ns	93 ns	93 ns
	L2	93	94 ns	92 ns	91 ns
	L3	94	92 ns	91 ns	90 ns
	L4	93	94 ns	93 ns	91 ns

ns: does not differ significantly from the sampling intensity indicated in the RAS (A40). Users: tetrazolium.

3.2. Effect of Sampling Intensity on Wheat Seed Quality

For wheat, the results obtained with the reduced sampling intensities A30, A20, and A10 remained within the tolerance limits established by the Rules for Seed Analysis (RAS) when compared with the reference sampling intensity A40 (Tables 1 and 2).

Physical purity values remained within the corresponding RAS tolerance limits for all cultivars and lots. For BRS Tarumaxi, the values obtained across the evaluated sampling intensities ranged from 99.5 to 100.0%, whereas for ORS Guardião they ranged from 99.6 to 100.0% (Table 1).

No other seeds were detected in any wheat sample, regardless of sampling intensity. Inert material remained at 0.0% in all evaluated conditions. Thus, for these parameters, no difference exceeding the applicable RAS tolerance limit was observed.

For germination, the values obtained with A30, A20, and A10 remained within the corresponding RAS tolerance limits relative to A40. For BRS Tarumaxi, germination values ranged from 91 to 98%, while for ORS Guardião they ranged from 90 to 94% (Table 2).

Tetrazolium viability ranged from 91 to 99% for BRS Tarumaxi and from 90 to 95% for ORS Guardião. The differences between the reduced sampling intensities and A40 remained within the corresponding RAS tolerance limits (Table 2).

3.3. Effect of Sampling Intensity on Rice Seed Quality

For rice, the results obtained with A30, A20, and A10 also remained within the tolerance limits established by the RAS when compared with A40 for all cultivars and lots evaluated (Tables 3–5).

Physical purity remained high across all sampling intensities. For IRGA 424 RI, values ranged from 99.7 to 100.0%; for Pampeiro, from 99.6 to 100.0%; for Guri INTA CL, from 99.7 to 100.0%; and for IRGA 431 CL, from 99.7 to 100.0% (Table 3).

Germination values ranged from 90 to 97% across cultivars, lots, and sampling intensities. The differences between A30, A20, and A10 and the reference intensity A40 did not exceed the corresponding RAS tolerance limits (Table 4).

Tetrazolium viability ranged from 90 to 99% across cultivars, lots, and sampling intensities. Similarly, the differences between the reduced sampling intensities and A40 remained within the corresponding RAS tolerance limits (Table 5).

Overall, for both wheat and rice, reducing the number of simple samples collected directly from the seed lots from 40 (A40) to 30 (A30), 20 (A20), or 10 (A10) did not result in differences exceeding the tolerance limits established by the RAS for the evaluated seed quality attributes.

Therefore, under the conditions of the seed lots evaluated in this study, the reduced sampling intensities produced results that remained within the applicable RAS tolerance limits relative to the reference sampling intensity of 40 simple samples.

4. Discussion

The results obtained in the present study showed that the reduced sampling intensities (A30, A20, and A10) produced results within the tolerance limits established by the Brazilian Rules for Seed Analysis (RAS) when compared with the reference sampling intensity (A40). This behavior was observed for the quality attributes evaluated in wheat and rice seed lots, including physical purity, determination of other seeds and inert material (D.O.S./M.I.), germination, and viability by the tetrazolium test. Therefore, under the conditions of the seed lots evaluated, reducing the number of simple samples from 40 to 30, 20, or 10 did not result in differences exceeding the applicable RAS tolerance limits.

According to [12] (p. 9), the reliability of seed analyses is directly related to obtaining representative samples, with seed-lot homogeneity being an important factor affecting the consistency of laboratory results. The International Seed Testing Association (ISTA) also emphasizes that appropriate sampling and sample-reduction procedures are essential for obtaining samples that adequately represent the seed lot and for reducing variability among samples. Therefore, the number of simple samples collected from a seed lot is an important component of the sampling procedure, since an insufficient number of samples may increase the risk that the laboratory sample does not adequately reflect the variability present within the lot. In contrast, when the quality attributes of a lot are relatively uniform, reductions in sampling intensity may result in smaller variations among the analytical results.

In the wheat lots, physical purity remained high at all sampling intensities evaluated, with values ranging from 99.5 to 100.0% (Table 1). No other seeds or inert material were detected in the evaluated samples. The consistency of these results across the different sampling intensities indicates that the reduction in the number of simple samples did not result in differences exceeding the applicable RAS tolerance limits for physical purity. In addition, the values observed were within the minimum standards established for seed commercialization in Brazil [13] (p. 9).

Similar results were described by [14] (p. 9), who observed high physical purity in rice seed lots subjected to different production and processing conditions, highlighting the importance of cleaning and classification procedures for obtaining seeds with low levels of impurities. In the present study, the consistent physical purity observed among sampling intensities may be associated with the initial physical quality of the evaluated lots.

For wheat, germination remained above 90% at all sampling intensities evaluated (Table 2). The values observed for BRS Tarumaxi ranged from 91 to 98%, whereas ORS Guardião ranged from 90 to 94%. These values are presented descriptively to characterize the evaluated lots and were not used to establish statistical comparisons between cultivars. The numerical variations observed among the sampling intensities remained within the applicable RAS tolerance limits relative to A40. Thus, under the conditions of the evaluated lots, reducing the number of simple samples did not result in differences sufficient to alter the interpretation of germination results.

The maintenance of high germination percentages may be associated with the physiological quality of the evaluated lots. According to [15] (p. 9) and [16] (p. 8), the physiological quality of wheat seeds can vary depending on genotype, environmental conditions during cultivation, maturation, and storage. However, appropriate production, processing, and storage conditions may contribute to maintaining greater uniformity in seed quality and reducing variability among samples.

The results obtained are also in agreement with [17] (p. 9), who highlighted that wheat seeds with high physiological quality may exhibit uniform germination when produced and stored under appropriate conditions. Similar results were observed by [18] (p. 9), who found germination values above 90% in wheat lots produced in northern Paraná, associating this performance with favorable production conditions and the high physiological quality of the seeds. Similarly, refs. [4] (p. 8) and [19] (p. 9) reported germination values above the minimum standards established for wheat seed commercialization, corroborating the high germination values observed in the present study.

The tetrazolium test also showed high viability in the wheat lots, with values ranging from 90 to 99% across the sampling intensities evaluated (Table 2). The results obtained with A30, A20, and A10 remained within the applicable RAS tolerance limits relative to the A40 reference intensity. The consistency between the germination and tetrazolium results is compatible with the high physiological quality observed in the evaluated lots. The tetrazolium test is an efficient tool for rapid evaluation of seed viability because it allows the identification of the metabolic activity of living tissues through the reduction in tetrazolium salts by respiratory enzymes [3] (p. 8); [20] (p. 9).

Similar results were reported by [21] (p. 9), who evaluated different wheat cultivars and observed percentages of viable seeds higher than 90%, demonstrating the usefulness of the tetrazolium test for assessing seed viability. In the present study, the high viability values obtained across the sampling intensities were consistent with the high physiological quality observed in the evaluated wheat lots.

In the rice lots, physical purity also remained high across all sampling intensities evaluated, with values ranging from 99.6 to 100.0% (Table 3). Other seeds and inert material were not detected in the evaluated samples. No damaged or mechanically damaged seeds

(D.O.S./M.I.) were detected in any cultivar, lot, or sampling intensity; therefore, these data were not presented separately. The absence of differences exceeding the applicable RAS tolerance limits among A40, A30, A20, and A10 indicates that, under the conditions of the evaluated lots, reducing the sampling intensity did not alter the interpretation of physical purity.

Rice seed germination remained above 90% in all cultivars and lots evaluated (Table 4). The values observed ranged from 90 to 97% across the different sampling intensities. These values are presented descriptively to characterize the evaluated seed lots and should not be interpreted as statistical comparisons among cultivars, since cultivar was not established as a factor for comparison in the experimental design. The variations observed among sampling intensities remained within the applicable RAS tolerance limits relative to A40, indicating that the reduced sampling intensities did not result in differences sufficient to alter the interpretation of germination under the conditions of the study.

Similar results were found by [22] (p. 8), who observed high physiological quality in rice seeds subjected to different treatment and storage conditions, with germination values above 90%. The authors highlighted that adequate postharvest management practices contribute to greater physiological stability during storage. Similarly, ref. [23] (p. 9), evaluating seeds of the IRGA 424 RI cultivar subjected to chemical treatment and storage, found high germination values, reinforcing the physiological quality observed in that material.

The viability of rice seeds evaluated by the tetrazolium test also remained above 90% at all sampling intensities (Table 5). The results obtained with A30, A20, and A10 remained within the applicable RAS tolerance limits relative to A40. The numerical differences among the evaluated lots and cultivars are presented only as descriptive information and were not used to establish statistical comparisons among cultivars. Therefore, the results indicate that reducing the number of simple samples did not result in differences exceeding the tolerance limits used to interpret the tetrazolium results.

Similar results were reported by [24] (p. 9), who found high viability in rice seeds subjected to different storage periods and treatments, highlighting the influence of conservation conditions on the maintenance of physiological quality. The consistency between the germination and tetrazolium results observed in the present study is compatible with the high initial physiological quality of the evaluated seed lots.

The results obtained for wheat and rice indicate that reducing the number of simple samples from 40 to 30, 20, or 10 produced results within the tolerance limits established by the RAS for the quality attributes evaluated. This finding is relevant because seed quality for commercialization is assessed through laboratory analyses performed on samples intended to represent the seed lot. Consequently, the sampling procedure is an important component of seed quality control. An insufficient number of simple samples may increase the risk of obtaining a laboratory sample that does not adequately reflect the variability present in the lot, potentially affecting the reliability of the analytical results and their interpretation for quality assessment.

However, this response should be interpreted considering the specific conditions of the present study. The evaluated wheat and rice seed lots presented high physical purity and high germination and viability values, while other seeds and inert material were not detected in the evaluated samples. These characteristics may have contributed to the consistency of the results obtained with the different sampling intensities.

In heterogeneous lots, with greater variation in physical quality, a higher presence of impurities or seeds of other species, mechanical damage, or different levels of deterioration, the behavior of reduced sampling intensities may differ. Greater variability within the lot may increase the importance of collecting enough simple samples to adequately capture the variation present in the lot and obtain a representative laboratory sample. Under these

conditions, reducing the number of simple samples may increase the risk of differences between the laboratory result and the actual quality characteristics of the seed lot [25] (p. 9).

Therefore, the present results indicate that, under the conditions represented by the evaluated commercial wheat and rice seed lots, sampling intensities lower than the A40 reference intensity produced quality results within the tolerance limits established by the RAS. These findings should not be interpreted as establishing a universal sampling intensity for all seed lots. Rather, they indicate that the reduced intensities evaluated were consistent with the A40 reference under the specific conditions of the lots analyzed. Further studies involving a larger number of seed lots, different levels of seed-lot heterogeneity, storage conditions, seed categories, and species are needed to assess the applicability of reduced sampling intensities under a broader range of conditions.

5. Conclusions

The reduction in the sampling intensity to up to 25% of the number of simple samples recommended by the Rules for Seed Analysis did not significantly alter the results of physical purity, determination of other seeds, inert material, germination and tetrazolium in the lots of wheat and rice seeds evaluated. In processed and homogeneous lots, the reduction in sampling intensity proved to be technically feasible under the conditions of this study.

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