SEED QUALITY CHARACTERIZATION OF SOYBEAN CULTIVARS

AYALA AGUILERA, Líder[1]; MENEZES, Nilson Lemos[2]

[1]Seed Science & Technology Course, Universidade Federal de Pelotas. 96001-970. Pelotas, RS, Brazil. lider@minerva.ufpel.tche.br
[2]Dep. de Fitotecnia, Centro de Ciências Rurais (CCR) / Universidade Federal de Santa Maria (UFSM). 97105-900, Santa Maria, RS, Brazil
(Recebido para publicação em 02/08/2000)

ABSTRACT

The objective of this work was to evaluate the physiological seed quality of seven soybean cultivars of early cycle in Rio Grande do Sul State, Brazil. The seeds were produced in a regional cultivar trial tests (Julio de Castilhos/RS/Brazil), and stored at a cold chamber at 10ºC and 35% RH. The seeds were evaluated twice, in may/97 and november/97, by morphological description (hilum and hypocotyl color, hilum shape) and physiological characterization (standard germination, accelerated aging, electrical conductivity, tetrazolium test, and determination of root and hypocotyl length). A peroxidase test was performed and also the weight of a thousand seeds (WTS) was checked. The statistical design was completely randomized in a 7x2-bifactorial arrangement. The multiple mean comparison was performed using Duncan's test. The results showed that those soybean seeds had good germination and vigor, but quality was slightly reduced after six months, even on good storage conditions. Differences among cultivars were small. Standard germination, accelerated aging and conductivity tests were able to select soybean cultivars in relation to seed quality. The soybean cultivars produced in 1996/1997 and evaluated on cultivar trial test showed good physiological seed quality.

*Key words: cultivar, **Glycine max**, quality, vigor.*

RESUMO

CARACTERIZAÇÃO DE CULTIVARES DE SOJA QUANTO A QUALIDADE DE SEMENTES. Avaliou-se a qualidade fisiológica de sete cultivares de soja, por meio da caracterização física e fisiológica das sementes. As sementes foram avaliadas em duas épocas, maio/1997 e novembro/1997, pelas seguintes metodologias: caracterização morfológica das sementes e plântulas, determinando-se cor e forma do hilo e cor do hipocótilo; teste da peroxidase e peso de mil sementes. A caracterização fisiológica avaliada mediante o teste de germinação; envelhecimento acelerado; condutividade elétrica; tetrazólio (vigor: Tz 1-3); comprimento da parte aérea e da raiz. O delineamento experimental foi inteiramente casualizado, com esquema bifatorial (7x2), sete cultivares e duas épocas de avaliação. A maioria das cultivares tiveram, no decorrer do tempo, uma pequena queda na sua qualidade, em termos de germinação e vigor. Ocorreu redução na qualidade fisiológica das sementes de soja, após seis meses, mesmo quando foram favoráveis as condições de armazenamento. Os testes de germinação, envelhecimento acelerado e condutividade elétrica foram capazes de estratificar cultivares de soja, em função de sua qualidade fisiológica. As sete cultivares de soja estudadas correspondentes à safra 1996/1997, apresentaram boa qualidade fisiológica de sementes.

*Palavras-chave: cultivar, **Glycine max**, qualidade, vigor.*

INTRODUCTION

Brazil is one of the largest soybean producers in the world. In 1996/97 and 1997/98 period, Brazil produced 26.4 million tons and 31.2 million tons of soybean respectively (IBGE, 1999). With this expansion, the seed demand for planting increased, and the seed quality is an important factor to be considered, especially in new production areas.

In the breeding programs, plant diseases are being more important than seed quality, because plant diseases represent a mayor loss in production and stand establishment; thus, resistant cultivars to pathogens might have poor seed quality. The difficulties for good seed quality production could not be in the field, but in the cultivar itself. Seed quality components essentially fall into three categories, accurate description, hygiene, viability and potential performance (ISTA, 1995); however, for many important cultures, only the physical purity of lot, the seed moisture content and the germination test are used to estimate the seed quality. Incomplete information regarding to soybean seed quality makes its use difficult, and causes inconveniences in the implantation period. Thus, description of each cultivar has to include all the characteristics to evaluate correctly its potential.

Using the correct methods to evaluate the physiological seed quality, besides giving information about seed viability, may also estimate seed performance during storage and field emergence, and therefore, to decide about the seed lot with poor quality, reducing the risk for the farmers.

The objective of this work was to evaluate the seed quality of seven soybean cultivars by physiological characterization of the seeds.

MATERIAL AND METHODS

This work was developed in Laboratory of Seed Analyses (LAS), Crop Science department, Federal University of Santa Maria (UFSM), Santa Maria, RS State, Brazil. Seeds of seven soybean cultivars (CEP-16 TIMBÓ, IAS-5, IVORÁ, FT-2003, FT-GUAÍRA, FT-SARAY and OCEPAR-14) were produced in a regional cultivar trial tests (Julio de Castilhos, RS), and seed quality was evaluated twice, in may/1997 and november/1997; all cultivars are classified as early cycle and recommended for planting in the south region of RS State, Brazil. During the experimental period, seeds were stored at 10°C and 35% RH.

Morphological characterization: using four samples of 50 seeds/seedling for each cultivar, hilum and hypocotyl color and hilum shape were evaluated visually, to confirm that the cultivars were the real ones. Peroxidase test: seed coat of individual seed was soaked in 10 drops of 0.5% guaiacol solution for 10 min, a drop of 0.1% hydrogen peroxide was added, and the presence or absence of color was recorded after 20 to 40 sec. (BUTTERY & BUZZELL, 1968; COSTA *et al*., 1980). Weight of a thousand seeds (WTS): eight replications of 100 seeds for each cultivar were weighted according to Rules for seed testing (BRASIL, 1992). Standard germination (SG): it was assessed according Rules for seed testing (BRASIL, 1992) except the replications that were four of 50 seeds for each cultivar. Accelerated aging (AA): prior to SG, four replications of 50 seeds of each cultivar were exposed to 41°C at 100% RH. for 48 hours (KRZYZANOWSKI *et al*., 1991). Electrical conductivity (EC): using four replications of 25 seeds for each cultivar, the EC was measured after soaking the seeds in plastic cups with 75 ml of distilled water, at 25°C for 24 hours (VIEIRA & CARVALHO, 1994). Tetrazolium test: using four replications of 50 seeds for each cultivar, presoaking for 16 hours at 25°C, seeds were immersed in 1% tetrazolium solution at 40 °C for 180 min. The vigor was classified from 1 to 3 classes respectively according to FRANÇA NETO *et al*. (1988). Hypocotyl and root length of normal seedling (HL, RL): they were measured using four replications of 25 seeds for each cultivar; seeds were placed in germination chamber at 25 ° C and evaluated on the fifth day (KRZYZANOWSKI *et al*., 1991).

Statistical design was completely randomized in a 7x2-bifactorial arrangement, seven cultivars and two evaluation periods with four replications. The multiple mean comparison was performed using Duncan's test.

RESULTS AND DISCUSSIONS

The majority of the cultivars has similar morphological characteristics, (Table 1) long hilum and brown or light brown hilum color were predominant, only FT-GUAÍRA had black hilum. Cultivars with purple hypocotyl are FT-GUAÍRA, CEP-16 and FT-SARAY. Only FT-2003 had negative peroxidase reaction. All cultivars were agreed with standard cultivar description, revealing high physic pure of lots.

WTS analyses showed differences among cultivars IAS-5 and CEP-16 TIMBÓ have greatest weight and OCEPAR-14 and FT-SARAY the lowest value. Seed weight has been shown to be a valid indicator of vigor for certain crop species with small seed exhibiting reduced seedling growth rates. However, results were contradictory when comparing crop species with large seed, because seed weight varies from one year to another due to many factors: handling, fertilizer, weather and others. Nevertheless, generally farmers consider large seeds more vigorous than smaller ones, even though large seeds yields not more than plants developed from small seeds (BYRD, 1967; SCOTTI & KRZYZANOWSKI, 1977).

TABLE 1. Hilum and hypocotyl color, hilum shape, peroxidase reaction and weight of thousand seeds (WTS) of seven soybean cultivars

Cultivars	Hilum Color	Hilum Shape	Hypocotyl shape	Peroxidase reaction	WTS (g)
IAS-5	light brown	Long	green	+	174,88 a*
CEP-16 TIMBÓ	brown	Long	purple	+	172,81 a
IVORÁ	light brown	Long	green	+	167,21 b
FT-GUAÍRA	black	Long	purple	+	166,18 b
FT-2003	light brown	Long	green	-	144,12 c
OCEPAR 14	brown	Long	green	+	134,31 d
FT-SARAY	brown	Long	purple	+	133,12 d
Average					156,00
C.V. (%)					2,56

***** - Means within columns followed by the same letter are not significantly (P> 0.01).

In all variables analyzed (SG, AA, TZ, HL and RL) except EC, significant differences occurred between the average of the first (may/1997) and the second evaluation (november/1997). Those results (Table 2) are consequence of deterioration of seed quality during the storage period, but reduction was small. Such germination decreased from 91% to 88%, maintaining over a minimum seed germination required for trading in Rio Grande do Sul state, Brazil (SAA, 1998). EC results suggested that seeds had small membrane damage between the evaluation period.

TABLE 2. Average of Standard germination test (SG), electrical conductivity (EC), accelerate aging (AA), tetrazolium test (vigor: 1-3), hypocotyl length (HL) and root length (RL) at 0 and 6 months

	SG (%)	AA (%)	EC µS/cm/g	Tetrazolium Vigor 1-3 (%)	HL (cm)	RL (cm)
0 month	91 a*	76 a	59,82 a	84 a	9,87 a	16,38 a
6 months	88 b	69 b	58,78 a	81 b	7,17 b	13,48 b
C.V. (%)	2,85	6,13	7,72	2,57	5,97	9,39

***** - Means within columns followed by the same letter are not significantly (P> 0.01).

Comparison among cultivars (Table 3) showed that amplitude of differences in the SG test was small. The difference between maximal and minimum value of SG was only 6%. SG results showed that FT-SARAY cultivar had the largest value, and no statistical differences were observed with FT-GUAÍRA and OCEPAR 14 cultivars; CEP-16 TIMBÓ and IAS-5 obtained the lowest performance, however they had high TSW (Table 1).

AA test was more accurate for detecting seed quality differences between cultivars. FT-GUAÍRA cultivar had the largest value and did not have difference between IVORÁ and FT-2003 cultivars. Also, FT-GUAÍRA obtained high percentage of germination. OCEPAR-14, FT-SARAY and CEP-16 TIMBÓ cultivars had the lowest performance in AA test.

Lower seed germination and vigor founded in some cultivars on the second evaluation were attested principally by tetrazolium test, showed that seeds of some cultivars had more deterioration in its quality than others. Likewise, decreases of soybean seed quality and vigor, using SG, AA and EC tests, was observed by CARVALHO & NAKAGAWA (1988); AHRENS & PESKE (1994) and AGUERO *et al*. (1997).

In this study, the rate of seed deterioration was considered normal, because usually soybean seed quality slightly decreases during conventional storage conditions as it was also found by SALINAS (1996), AGUERO *et al*., (1997) BARROS & MARCOS FILHO (1997). The reduction of seed metabolic activity may be detected by lower vigor and poor germination, and it could be a consequence of increasing degradation or reduction of biosynthetic activity of certain seed storage enzymes (ABDUL-BAKI, 1969). This degradation is affected by environmental factors such as agronomic practices, late harvest, mechanical damage, inadequate storage, diseases and cultivar genetic characteristics.

TABLE 3. Standard germination (SG), accelerate aging (AA), electrical conductivity (EC) and tetrazolium test (vigor: classes 1-3) of seven soybeans cultivars

	SG (%)	AA (%)	EC (µS/cm/g)		Vigor % (1-3)	
Cultivars			0 month	6 months	0 month	6 months
FT-SARAY	92 a*	69 cd	54,36 cA	53,75 bcA	83 bA	83 abA
FT-GUAÍRA	91 ab	79 a	53,26 cA	50,15 cA	87 bA	83 aB
OCEPAR-14	90 ab	70 bcd	54,46 cA	56,29 bcA	89 aA	79 bcB
IVORÁ	90 b	75 ab	62,29 bA	59,02 bA	83 bA	81 abcA
FT-2003	89 b	75 ab	76,90 aA	68,78 aB	81 bA	81 abcA
CEP-16 TIMBÓ	87 c	65 d	60,22 bcA	57,80 bA	84 bA	81 abcB
IAS-5	86 c	72 bc	57,28 bcB	65,65 aA	83 bA	78 cB
Average	89	72	59,82 A	58,78 A	84 A	81B
CV (%)	2,64	6,12	6,58	8,75	3,92	2,60

***** - Means within rows followed by the same upper letter or within columns followed by same lowercase letter are not significantly (P> 0.01).

The EC results showed FT-2003, CEP-16 TIMBÓ and IAS-5 cultivars with high EC values in two evaluation periods, indicating lower vigor; besides, they had lower values in SG and AA. Similar values on soybean seed quality along this time were found by PASCHAL & ELLIS (1978), and SEDIYAMA *et al*. (1987).

Differences in evaluation periods and among cultivars were obtained for HL and RL, in spite of high CV values (Table 4). Studies reported low accuracy on the measurement of seedling rate growth. ESTEFANEL *et al*. (1987) observed that CVs of root weight and aerial parts of corn plants were 20,9% and 33,1% respectively. MOREOVER, SANTOS *et al*. (1987) concluded that dry matter per seedling is not a good method for seed quality evaluations. Differences among cultivars in HL may be influenced not only by seed vigor, but also by cultivar characteristics (GILMAN *et al*., 1973; NOBREGA & VIEIRA, 1995). A problem regarding this evaluation is that the rate of hypocotyl elongation may be different among cultivars (BURRIS *et al*., 1973; AOSA, 1983) and not necessarily represents differences in vigor. Hypocotyl root length showed statistical differences among cultivars within two evaluation periods. Only IVORÁ did not have HL reduced; IVORÁ and FT-2003 did not have statistical differences on root length between evaluated times. Reduced hypocotyl and root length are evidence of reduced seed vigor (NOBREGA & VIEIRA, 1995), thus, reduced HL and RL were, probably, a consequence of little dry matter transference of seed storage reserves to hypocotyl and root.

TABLE 4. Hypocotyl seedling length (HL) and root seedling length (RL) of seven soybean cultivars

	HL (cm)		RL (cm)	
Cultivars	0 month	6 month	0 month	6 month
FT-SARAY	11,32 a* A	7,66 aB	16,02 aA	12,49 cdB
OCEPAR-14	10,97 abA	7,92 aB	16,18 aA	13,33 bcB
FT-GUAÍRA	10,40 bcA	7,54 aB	17,29 aA	12,46 cdB
CEP-16 TIMBÓ	9,70 cdA	5,40 bB	17,26 aA	10,81 dB
FT-2003	9,21 dA	7,84 aB	16,58 aA	15,76 aA
IAS-5	9,17 dA	5,80 bB	17,38 aA	14,28 abcB
IVORÁ	8,36 eA	8,01 aA	13,99 bA	15,24 abA
Average	9,87 A	7,17 B	16,38 A	13,48 B
CV (%)	5,69	6,27	11,32	5,19

***** - Means within rows followed by the same upper letter or within columns followed by same lowercase letter are not significantly (P> 0.01).

Generally, all cultivars showed a decrease in seed vigor during storage period, so as in its quality. However, the minimum value observed in tetrazolium test was 78%, showing that reduction of seed quality was little. Tetrazolium test showed similar results to other tests, and the cultivars had lower vigor in the second evaluation period. Again, CEP-16 TIMBÓ and IAS-5 had lower performance than other cultivars. Tetrazolium test was more sensitive to detect vigor changes between soybean cultivars in the second evaluation. Similar results using tetrazolium test were found by BARROS &

MARCOS FILHO (1997) when evaluating vigor of soybean seeds. They concluded that tetrazolium test is efficient for identifying soybean seed quality and potential field emergence.

TEKRONY *et al*. (1984) and MARCOS FILHO (1986) affirm that deterioration of soybean seed is much more affected by environmental factors than by genetic factors. Considering that in this work seeds of all cultivars were produced at the same time and soil conditions, harvested in R8 stage closer to the point of maximum seed vigor and dry matter, and stored in optimal conditions during the experiment period, reducing as much as possible the deterioration by environmental effects, the differences observed in seed quality probably were due to cultivar characteristics rather than environmental effects.

Seed quality had a slightly reduction during six months of storage, showing that the lots of soybean cultivars studied and produced in 1996/1997 had good physiological seed quality.

Considering results of the tests, it was observed that Ft-SARAY, FT-GUAÍRA and OCEPAR-14 had better results in SG and in some vigor tests; IVORÁ maintained medium results in various tests, and CEP-16 TIMBÓ and IAS-5 did not show to keep a high seed quality along the storage period.

The results of this work permit to rank cultivars according to physiological seed quality and confirm that physiological seed quality should be estimate based upon results from several different tests.

CONCLUSIONS

Soybean seeds slightly reduce their qualities after sixth month, even if maintained on good storage conditions.

Standard germination test, accelerate aging and conductivity test are good indicators to select soybean cultivars in relation to seed quality.

The comparison of morphological description of seed and seedling to standards is an inexpensive method to help in the soybean seed quality evaluation to prove which cultivars are the real one.

REFERENCES

ABDUL-BAKI, A.A. Relationship of glucose metabolism to germinability and vigor in barley and wheat seeds. **Crop Science**, Madison, v.9, p.732-737, 1969.

AGUERO, J.A.P.; VIEIRA, R.D.; BITTENCOURT, S.R.M. Avaliação da qualidade fisiológica de sementes de cultivares de soja. **Revista Brasileira de Sementes**, Brasília, v.19, n.2, p.255-260, 1997.

ANDERSON, J.D. Deterioration of seeds during aging. In : SYMPOSIUM ON DETERIORATION MECHANISMS IN SEEDS. **Phytopathology**. v.73, p.321-325, 1983.

AHRENS, D.C.; PESKE, S.T. Flutuações de umidade e qualidade em semente de soja após a maturação fisiológica. II Avaliação da qualidade fisiológica. **Revista Brasileira de Sementes**, Brasília, v.16, n.2, p.11-115, 1994.

ASSOCIATION OF OFFICIAL SEED ANALYSIS (AOSA) **Seed vigor testing handbook**. Lincoln : AOSA, 1983. 93 p. (Contribution, 32).

BARROS, A.S.R.; MARCOS FILHO J. Testes para a avaliação rápida da viabilidade e do vigor de sementes de soja. **Revista Brasileira de Sementes**, Brasília, v.19, n.2, p.289-295, 1997.

BURRIS, J.S.; EDJE, O.T.; WAJAB, A.H. Effects of seed size of seedling performance in soybeans. II Seedling growth and photosynthesis and field performance. **Crop Science**, Madison, v.13, p.207-210, 1973.

BUTTERY, B.R.; BUZZELL, R.I. Peroxidase activity in seeds of soybean varieties. **Crop Science**, Madison, v.8, n.6, p.722-725, 1968.

BYRD, H.W. Effects of fungicidal seed treatments and seed size on the performance of hybrid corn in Brazil. **Fitotecnia latinoamericana**, San José, Costa Rica, v.4, n.2, p.57-68, 1967

CARVALHO, N.M.; NAKAGAWA, J. **Sementes** : ciência, tecnologia e produção. 3. ed. Campinas : Fundação Cargill, 1988. 428 p.

COSTA, N.P.; PEREIRA, L.A.G.; FRANÇA NETO, J.B. **Método da peroxidase para identificação de cultivares de soja** : Comunicado Técnico. Londrina : EMBRAPA. CNPSo n.4, mar. 1980. 3p.

ESTEFANEL, V.; PIGNATARO, I.A.B.; STORCK, L. Avaliação do coeficiente de variação de experimentos com algumas culturas agrícolas. In : **SIMPÓSIO DE ESTATÍSTICA APLICADA À EXPERIMENTAÇÃO AGRONÔMICA**, 2., Londrina, jul. 1987. **Anais**.. Londrina : DME/CCE/Universidade Estadual de Londrina, 1987. 325 p. p.115-131.

GILMAN, D.F.; FEHR, W.R.; BURRIS, J.S. Temperature effects on hypocotyl elongation of soybeans. **Crop Science**, Madison, v.1, n.2, p.246-249, 1973.

IBGE. **Produção de soja no Brasil**. Disponível na INTERNET via http:// www.sidra.ibge.gov.br Arquivo consultado em 1999.

ISTA. **Handbook of vigor test methods**. 3. ed. Zurich, 1995. 117 p.

KRZYZANOWSKI, F.C.; FRANÇA NETO, J.B.; HENNING, A.A. Relato dos testes de vigor disponíveis para grandes culturas. **Informativo Abrates**, Londrina, v.1, n.2, p.15-50, 1991.

MARCOS FILHO, J.; CARVALHO, R.V.; CÍCERO, S.M. *et al*... Qualidade fisiológica e comportamento de semente de soja (*Glycine max* (L) Merrill) no armazenamento e no campo. **Anais da Escola Superior de Agricultura Luís de Queiroz**, Piracicaba, v.43, p.389-443, 1986.

MENEZES, N.L.; SILVEIRA, T.L. Métodos para avaliar qualidade fisiológica de sementes de arroz. **Scientia Agricola**, Piracicaba, v.52, n.2, p.350-359, mai/ago. 1995.

NOBREGA, L.H.P.; VIEIRA, R.D. Avaliação e classificação de cultivares de soja, quanto ao comprimento do hipocótilo, sob condições de laboratório e casa e vegetação. **Revista Brasileira de Sementes**, Brasília, v.17, n.2, p.160-164, 1995.

PASCHAL II, E.H.; ELLIS, M.A. Variation in seed quality characteristics of tropically grow soybeans. **Crop Science**, Madison, v.18, n.5, p.837-840, 1978.

SECRETARIA DE AGRICULTURA E ABASTECIMENTO- SAA. **Normas e padrões de sementes para o estado de Rio Grande do Sul**. Departamento da produção vegetal. CESM/RS. 2. Ed. 1998. 156 p.

SEDIYAMA, T.; SEDIYAMA, T.; SILVA, R.F. *et al*... Influência da época de semeadura e do retardamento da colheita sobre a qualidade das sementes e outras características agronômicas das variedades de soja UFV-1 e UFV-2, em Capinópolis, Minas Gerais. In: SEMINÁRIO NACIONAL DE PESQUISA DE SOJA, 2., 1981, Brasília. **Anais..** Londrina: EMBRAPA-CNPSo, 1982. v.1, p.645-660.

SALINAS, A.R. **Fisiologia da deterioração em sementes de soja (Glycine max (L.) Merrill) durante o armazenamento.** Pelotas : UFPEL, 1996. 115 p. Tese (Doutorado em Agronomia) Universidade Federal de Pelotas, 1996

SANTOS, V.L.M.; SILVA, R.F.; CARDOSO, A.A. *et al*. Avaliação da qualidade de sementes de soja (Glycine max (L.) Merrill) colhidas em duas épocas, utilizando-se temperaturas sub e supra-ótimas. **Revista Brasileira de Sementes**, Brasília, v.18, n.1, p.57-56. 1996.

SCOTTI, C.A.; KRZYZANOWSKI, F.C. Influência do tamanho da semente sobre a germinação e vigor em milho. **Boletim Téc. IAPAR**. Londrina, v.5, p 1-10. 1977.

VIEIRA, R.D. **Avaliação da qualidade fisiológica de sementes de quatorze cultivares de soja (Glycine max (L) Merrill).** Viçosa : UFV, 1980. 76 p. Dissertação (Mestrado em Agronomia) Universidade Federal de Viçosa, 1980.

VIEIRA, R.D.; CARVALHO, N.M. **Testes de vigor em sementes**. FUNEP, 1994. 164 p.