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Onion seed vigor in relation to plant growth and yield

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ABSTRACT

Research has emphasized the relationship of laboratory germination and vigor to seedling emergence and stand establishment, but information relating seed vigor to plant performance is less available. The reliable procedures to evaluate onion (*Allium cepa L.)* seed vigor and decided the differences between seed physiological potential influence plant performance in field conditions were identified in two experimental years. Six seed lots of Petroline cultivar were evaluated for germination and vigor, in laboratory, and field seedling emergence. Field experiments were performed by direct sowing and transplant systems and all treatments had equal stand for both cropping systems. Results demonstrated that saturated salt accelerated aging (41ºC/72h) and controlled deterioration (24% moisture content/45ºC/24h) were the most valuable vigor tests for onion seeds. The potassium leachate and seedling vigor classification tests were also efficient but less sensitive to vigor differences among seed lots. Initial plant development during the first 56 days, as measured by plant height and dry matter accumulation, was affected by seed vigor mainly when differences on seed physiological potential became wider as a result of the storage period. Influence of seed vigor did not persist during plant vegetative growth and did not affect yield. The use of high vigor seed lots is justified to ensure adequate stand establishment under different environmental conditions.

Keywords: *Allium cepa*, seed physiological quality, stand establishment, plant performance.

RESUMO

Relações entre vigor de sementes, desenvolvimento e produção de cebola

A pesquisa tem enfatizado a existência de relações entre resultados de testes de germinação e vigor, conduzidos em laboratório, mas informações sobre a associação com a emergência de plântulas e o estabelecimento do estande em campo são menos disponíveis. Este trabalho foi desenvolvido, em dois anos experimentais, com o objetivo de identificar procedimentos seguros para avaliar o vigor de sementes de cebola e determinar até que ponto as diferenças entre o potencial fisiológico das sementes pode afetar o desempenho e a produção das plantas em campo. Para tanto, seis lotes de sementes da cv. Petroline foram avaliados quanto à germinação e ao vigor, em laboratório e à emergência de plântulas em campo. Em seguida, nos dois anos experimentais, foram conduzidos ensaios de campo, utilizando os sistemas de semeadura direta e de transplante, procurando-se obter o mesmo estande para todos os tratamentos, em ambos os sistemas de cultivo. Os resultados demonstraram que os testes de envelhecimento acelerado com solução salina (41ºC/72h) e de deterioração controlada (sementes com 24% de água/45ºC/24h) foram os mais eficientes para detectar diferenças no vigor das sementes. Os testes de lixiviação de potássio e de classificação do vigor de plântulas foram menos sensíveis às diferenças de vigor, mas indicaram diferenças entre os lotes. O desenvolvimento inicial, especialmente nos primeiros 56 dias, avaliado pela altura e peso da matéria seca das plantas foi afetado pelo vigor das sementes, principalmente quando as diferenças no potencial fisiológico das sementes tornaram-se mais amplas, como resultado da deterioração durante armazenamento. A influência do vigor das sementes não persistiu durante o desenvolvimento vegetativo das plantas e não houve efeito na produção de bulbos. Desta forma, concluiu-se que a utilização de sementes de alto vigor é justificável para assegurar o estabelecimento de estande adequado sob diferentes condições ambientais.

Palavras-chave: *Allium cepa*, potencial fisiológico, estabelecimento do estande, desempenho de plantas.

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The demand for high quality vegetable seeds increased as new technology (seed enhancements, germination in plug flats, precision mechanical planting, transplant systems and greenhouse) production spurred interest, thus emphasizing the attention to seed performance.

Although research considers all attributes of seed quality, e.g., genetic, physical, physiological and pathological, literature shows that the physiological component has received more attention with an emphasis on studies regarding reliable procedures for seed vigor evaluation and identification of the relationship between seed vigor and seedling emergence.

Unfortunately, not only in Brazil but in other countries as well most procedures used for vegetable seed vigor testing are usually adapted from those recommended for grain crop species even though the electrical conductivity (Matthews & Bradnock, 1967) and the controlled deterioration (Matthews, 1980) tests have been developed for vegetable seeds.

To date, no one vigor test is considered universally accepted for onion seeds but some have been recognized for their effectiveness and research continues moving towards standardization. Among the tests studied

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for assessment of onion seed vigor, the following have shown to relate to seedling emergence: controlled deterioration (Powell & Matthews, 1984; Powell, 1995); accelerated aging (Piana *et al*., 1995a); cold test (Piana *et al.*, 1995a; Torres, 1998). McDonald (1999) reported that the seedling growth rate, speed of germination and electrical conductivity tests were positively associated to onion seed vigor. In contrast, Lima (1993), Piana *et al*. (1995b) and Torres (1998) did not recognize the electrical conductivity as a reliable test for onion seeds.

Although the accelerated aging vigor test is widely used for various species, it has limitations for most small-seeded crops, such as vegetable seeds, since seed samples absorb water more rapidly and at different rates, resulting in large variation in moisture content and wide differences in deterioration severity at the end of aging period (Powell, 1995; Rodo *et al*., 2000). As an alternative, the saturated salt accelerated aging has demonstrated to be efficient to assess seed vigor of small-seeded species, providing similar accuracy to that obtained from the controlled deterioration test (Jianhua & McDonald, 1996; Panobianco & Marcos-Filho, 1998; Rodo *et al*., 2000).

The potassium leachate test is based on a similar principle to the electrical conductivity test with the additional advantage of providing information on the physiological potential of seed lots in a considerably shorter period of time as already demonstrated for soybean (Custodio & Marcos-Filho, 1997) and tomato seeds (Panobianco & Marcos-Filho, 2001).

Seedling vigor classification is similar to the standard germination test. The main difference is that normal seedlings are classified as "strong" or "weak" according to irregularities or deficiencies symptoms. This test was successfully used by Rodo *et al*. (1998) for the evaluation of tomato seed vigor.

According to Ellis (1992) previous reviews reported that seed vigor can be assessed in laboratory and various procedures can be used to detect high and low vigor seed lots. Vigor may have a positive influence on seedling emergence in the field. However, because there is less information relating seed vigor to other aspects of crop performance, possible direct effects of seed vigor on plant development and yield are still difficult to discern.

Undoubtedly, if seed vigor affects yield, its influence should be discernible through some effects on plant growth processes; at the same time, it must be identified whether seed deterioration would affect subsequent plant growth rate.

The effects of seed vigor on stand establishment can be especially critical to crops that require spatial distribution of plants to maximize yield such as lettuce, cabbage, cauliflower, and onion (Tekrony & Egli, 1991). In this situation, delayed or lower seedling emergence may reduce yield at harvest, but the direct effect of seed vigor on plant growth and yield in the absence of population differences is controversial.

Literature shows that crops harvested during vegetative growth or early reproductive growth, such as many vegetable crops, can show positive relationship between seed vigor and yield as confirmed by Harrison (1966) for onions, Smith *et al*. (1973) for lettuce and Finch-Savage & McKee (1990) for cauliflower. In contrast, Ellis (1992) verified that despite absolute differences in seedling size, post-emergence growth rates did not differ among onion commercial seed lots of differing physiological potential.

Onion seeds have a high commercial value and the availability of satisfactory vigor tests for onion seeds is desirable. On the other hand, it is possible to detect effects of seed vigor on subsequent plant growth and performance but a more precise identification of this relationship is needed.

The objective of this study was to identify the accuracy of different procedures to assess onion seed vigor, according to their sensitivity, rapidity and consistency and to determine whether the differences in seed physiological potential detected in laboratory relate to seedling emergence, plant growth and yield.

MATERIAL AND METHODS

This study was conducted at seed laboratory and field experimental area of the Crop Science Department of USP/ESALQ, in Piracicaba/SP/Brazil, during two years (1999/2000 and 2000/2001).

1. Laboratory study: Six onion (*Allium cepa L.*) seed lots of Petroline cultivar varying in physiological potential were used in this study. The seed lots were stored in a chamber maintained at 20ºC and 60% relative humidity and tested for:

1.1. Germination: Four replications of 50 seeds each were placed on two layers of blotter paper moistened with water equivalent to 2.5 times the substratum weight and germinated on plastic boxes (11.0 cm x 11.0 cm x 3.5cm) at 20ºC. Seedling counts were performed at six and 12 days after planting. The mean percentage of normal seedlings was calculated for each lot.

1.2. Seedling vigor classification: This test was performed simultaneously with standard germination. At the preliminary count (six days) all seedlings which had complete morphological parts without lesions or defects were removed and computed as "strong" (high vigor) seedlings; those not meeting criteria established for strong seedlings were classified as normal or abnormal at the final count (12 days), according to the Brazilian Rules for Testing Seeds (Brasil, 1992). Normal seedlings were classified into "strong" or "weak" seedlings. Results were expressed as total percentage of "strong" seedlings per lot.

1.3. Saturated salt accelerated aging: A single layer (approximately 3.0 g) of each lot was placed on a wire mesh screen and suspended over 40 mL of saturated NaCl solution (40 g NaCl/100 mL distilled water) inside an accelerated aging plastic box. Boxes were held at 41ºC for 72 h. After this aging period, four replications of 50 seeds were tested for germination as described above. Seed moisture content (oven method, at 105ºC for 24 h) was also determined before and after the aging period.

1.4. Controlled deterioration: Seed moisture content was adjusted to 24% by hydration using the humid atmosphere method (Rossetto *et al*., 1995). Seeds were then packed in sealed

Table 1. Mean seed germination, seedling vigor classification, salt saturated accelerated aging, controlled deterioration and seedling emergence tests of five onion seed lots of ‘Petroline’. Piracicaba, USP/ESALQ, 1999/2000.

Seed lots	Germination	Seedling vigor classification	Salt saturated accelerated aging	Controlled deterioration	Seedling emergence
			%		
1	82 b*	59 b	64 d	69 c	70 d
2	94 a	74 a	86 ab	87 a	92 ab
3	91 a	60 b	79 bc	80 b	85 abc
4	79 b	51 b	61 d	68 c	77 cd
5	94 a	77 a	87 a	89 a	93 a
6	85 b	61 b	72 c	79 b	83 bc
C.V. (%)	3.5	6.1	3.8	2.5	4.4

* Mean comparison within each column (Tukey’s test, p< 0.05).

aluminum foil envelopes and placed in a water bath at 45°C for 24 h. Four replications of 50 seeds per lot were germinated as previously described.

1.5. Potassium leachate: Adjustment of flame photometer NK-2004 (Digimed, São Paulo, Brazil) was performed according to Custodio & Marcos-Filho (1997); the combination of 5 ppm $K^+.mL^{-1}$ and reading adjusted to 50 was considered the best for producing linearity and a high coefficient of determination. Four replicates (50 seeds each) were weighed to 0.1 g and placed in plastic cups containing 25 ml distilled water and kept in a germinator at 25°C for 30 min. The amount of leached potassium was determined in 5 mL aliquots withdrawn from each sample, using a flame photometer and the results were expressed as ppm K^+g^{-1} seeds.

1.6. Seedling emergence: Four replicates (50 seeds each) per lot were individually planted in trays (200 cells/ tray) containing a commercial growing mix (Plantmax®). Trays were placed in greenhouse conditions at 20°C, and irrigation was provided as necessary through a microaspersion system. Emerged seedlings with at least 1.0 cm hypocotyl length were counted 14 days after planting and the percentage of normal emerged seedlings was determined for each lot.

1.7. Statistical analysis: The statistical analysis was conducted separately for each test using a completely randomized design for the variance analysis. Multiple mean comparison was performed using Tukey’s test (p<0.05).

2. Field experiments: Field study was performed for two years (sowing in May 2000 and in June 2001) by direct sowing and transplant systems, in a randomized block design with four replications. The practices of land preparation, fertilizer applications, irrigation and weed control were standard for onion culture (Fontes, 1998); fertilizer amounts were based on soil analysis results and 30 kg N/ha, 300 kg P_2O_5/ha and 60 kg K_2O/ha were distributed in field plots. Irrigation was provided twice a day during the seedling emergence period and daily during plant development; at the end of plant cycle irrigation practice was avoided. Effects of seed physiological potential were overcome by adjusting seed rates according to germination percentage of each lot to obtain a stand of 14 plants/m after seedling emergence in a row spacing of 30 cm, under a direct sowing system.

Emergence count was made 14 days after sowing date to evaluate uniformity within rows of each lot. At the 28th day after sowing and at approximately 28-day intervals from there on, plant height and plant dry weight (oven method at 70°C) were determined by random sampling of four plants from each replication. Plants were carefully thinned, placed in polyethylene bags to avoid water loss before evaluation times. At harvest, treatments were rated for number of bulbs, bulb fresh weight and size and yield ($t.ha^{-1}$).

The same procedures were adopted in the transplant system experiment, except for sowing which was performed as described for the seedling emergence test. Seedlings were transplanted into a field plot when they had reached at least 15 cm height (42 days after sowing) to set up a 14 plants/m stand.

Statistical analysis of data was performed using a randomized block design and multiple mean comparison was according Tukey’s test (p<0.05).

RESULTS AND DISCUSSION

1. Laboratory study: Germination of seed lots, except for lot 4, was above the minimum germination standards (>80%) usually required for marketing onion seeds (Table 1). Information provided by seed vigor tests is not useful to support in-house quality control programs when seed lots do not attain the desirable quality for planting purpose. Consequently, a sensitive vigor test must detect differences in physiological potential among seed lots within the initial phase of the survival curve proposed by Powell (1986), in which germination remains high.

Germination of seed lots 1, 4 and 6 was significantly lower than lots 2, 3 and 5, in the first year. However no significant differences occurred within the lower and the higher quality lots (Table 1). Seedling vigor classification was slightly more sensitive than germination test to detect differences

Table 2. Mean seed germination, seedling vigor classification, salt saturated accelerated aging, controlled deterioration, potassium leachate and seedling emergence tests of five onion seed lots of ‘Petroline’. Piracicaba, USP/ESALQ, 2000/2001.

Seed lots	Germination	Seedling vigor classification	Salt saturated accelerated aging	Controlled deterioration	Potassium leachate	Seedling emergence
	%				ppm K+.g $^{-1}$	%
1	79 b*	61 c	64 bc	58 cd	594.9 b	77 c
2	83 ab	64 bc	79 ab	68 abc	694.3 b	90 a
3	82 ab	73 abc	66 bc	62 bcd	656.4 b	87 ab
4	80 b	72 abc	57 c	58 cd	892.0 c	80 c
5	90 a	80 a	80 a	78 a	418.6 a	92 a
6	80 b	73 ab	67 bc	70 ab	668.2 b	83 bc
C.V. (%)	6.2	5.8	6.5	7.8	10.3	3.3

*/ Mean comparison within each column (Tukey’s test, $p < 0.05$).

among seed lots and confirmed lots 2 and 5 to have the highest physiological potential. Since both tests were performed using the same seed samples, their efficacy was similar, as expected.

Saturated salt accelerated aging and controlled deterioration tests detected the lowest vigor of seed lots 1 and 4 and also indicated lots 5 and 2 as the highest quality (Table 1). The accuracy of these tests confirmed previous results of Panobianco & Marcos-Filho (1998) for bell pepper, Rodo *et al*. (2000) for carrot and Panobianco & Marcos-Filho (2001) for tomato seeds. A valuable vigor test for the seed industry must reveal different performance levels from high and low physiological potential seed lots, since the identification of intermediate vigor is almost impossible as values frequently overlap higher and/or lower quality lots, as verified for germination and seedling vigor classification tests (Table 1).

Seeds exposed to saturated salt accelerated aging exhibited initial seed water contents values ranging from 6.8% to 7.3% and from 11.2% to 12.1% after aging, which are markedly lower and more uniform than those observed after the traditional accelerated aging. Less variation of seed moisture would enhance standardization of this test for small seeds. In addition, results of the controlled deterioration test provided similar information to the saturated salt accelerated aging and demonstrated its ability to detect differences in seed quality of vegetable seeds as already emphasized by various researchers (Powell, 1995).

In regard to the second year, results of saturated salt accelerated aging and controlled deterioration tests provided similar information to the seedling emergence test, indicating seedlots 5 and 2 as highest vigor whereas performance of lots 1 and 4 in general were the lowest (Table 2). Seed quality was lower than that detected in the first year experiment, as a consequence of the natural deterioration during the storage period from 1999 to 2000 as seeds were not stored under controlled temperature and relative humidity conditions. In this situation even the germination and seedling vigor classification tests showed sensitiveness to differences in seed physiological potential.

The potassium leachate test was studied only for the second year experiment. Results provided similar information to the other vigor tests and regarding the identification of seed lots 5 and 4 as highest and lowest quality respectively (Table 2) in a reduced period of time (30 min). The saturated salt accelerated aging and controlled deterioration test produced information comparable to the seedling emergence test to indicate differences in seed physiological potential (Tables 1 and 2) and can be considered good alternatives for onion seed quality control programs. The disadvantage of the controlled deterioration test is that it requires careful handling to precisely adjust the seed moisture content to a specific level prior to the artificial aging.

Results from this two-year study provided useful information regarding the assessment of onion seed physiological potential, and indicated the saturated salt accelerated aging and the controlled deterioration tests as efficient to reveal differences in seed vigor of the lots evaluated and the potassium leachate test as a promising alternative vigor test for onion seed quality control programs.

2. Field experiments: Plant performance (plant height and dry weight; bulb diameter and fresh weight; crop yield) from all seed lots did not differ significantly in the first year experiment (data not shown). Thus plant development of both crop systems (direct sowing and transplant) was not related to differences in seed physiological potential detected by laboratory tests. Ellis (1992) emphasized that seed vigor may affect seedling emergence but the extent to which this parameter might influence subsequent seedling or plant growth is not clear enough. It is possible that the differences in seed physiological potential, as identified by the saturated salt accelerated aging and controlled deterioration tests were not sufficiently wide to affect plant development and yield in this first year field experiment.

In contrast, in the second year experiment (2000/2001), initial plant growth rate was associated to seed physiological potential. Plants from seedlot 5 did not differ from those from seedlot 2 and had greater size and dry

Table 3. Height (cm) and dry weight of plants at different stages of growth from six onion seed lots, cv. Petroline, in 2000/2001 field study, for the direct sowing cropping system. Piracicaba, USP/ESALQ, 2001.

Seed lots	Days after sowing					Days after sowing				
	28	56	84	98	112	28	56	84	98	112
	Plant height (cm)					Plant dry weight (g)				
1	6.6 b*	22.0 c	56.4 a	64.3 a	70.3 a	0.005 c*	0.153 b	2.370 a	4.278 a	8.568 a
2	9.3 a	29.2 a	58.7 a	66.4 a	73.8 a	0.009 a	0.315 a	2.513 a	5.398 a	9.578 a
3	8.4 ab	25.5 abc	58.4 a	65.0 a	74.4 a	0.008 a	0.260 ab	2.230 a	4.805 a	9.308 a
4	6.6 b	23.9 bc	54.5 a	60.6 a	66.9 a	0.007 b	0.190 b	1.996 a	3.975 a	7.963 a
5	9.6 a	28.7 a	56.3 a	65.7 a	73.9 a	0.009 a	0.338 a	2.158 a	4.765 a	7.890 a
6	8.6 ab	26.0 ab	55.8 a	64.6 a	73.0 a	0.008 ab	0.245 ab	2.005 a	4.783 a	8.465 a
C.V. (%)	11.9	6.7	7.1	8.6	5.9	8.6	19.9	22.1	24.4	19.5

*/ Mean comparison within each column (Tukey's test, p< 0.05).

Table 4. Plant height (cm) and dry weight at different stages of growth from six onion seed lots, cv. Petroline, in 2000/2001 field study, for the transplant cropping system. Piracicaba, USP/ESALQ, 2001.

Seed lots	Days after sowing					Days after sowing				
	28	56	84	98	112	28	56	84	98	112
	Plant height (cm)					Plant dry weight (g)				
1	9.8 b*	17.9 a	41.8 a	55.2 a	68.1 ab	0.014 d*	0.058 bc	1.21 a	1.95 a	4.23 b
2	12.4 a	19.2 a	37.1 a	50.3 a	71.2 ab	0.023 ab	0.071 ab	1.27 a	2.18 a	5.58 ab
3	10.8 ab	19.1 a	38.3 a	59.6 a	71.8 ab	0.018 bcd	0.066 abc	1.16 a	2.39 a	5.98 ab
4	9.9 b	18.1 a	39.2 a	49.5 a	61.8 b	0,016 cd	0.055 c	1.15 a	1.80 a	4.21 b
5	11.9 ab	21.2 a	44.8 a	57.3 a	77.2 a	0.026 a	0.076 a	1.63 a	2.73 a	8.53 a
6	11.6 ab	20.0 a	38.7 a	57.9 a	65.8 ab	0.021 abc	0.074 a	1.50 a	3.08 a	4.10 b
C.V. (%)	9.0	7.7	16.1	12.5	9.2	13.6	10.0	33.1	25.6	27.8

*/ Mean comparison within each column (Tukey's test, p< 0.05).

weight than plants from lots 1 and 4 at 28 and 56 days after sowing (Table 3). The same performance was observed in the transplanted crop, when plant dry weight from seedlots 5 and 2 was evaluated at 28, 56 and at 112 days after planting (Table 4). Differences in plant height were less evident but the best quality of lots 5 and 2 was and the lowest of lot 4 were confirmed at the 112-day evaluation (Table 4). These findings confirm that seed vigor may affect plant dry matter accumulation during the first stages of development. Most plant tissues involved in the production of dry matter are formed after seedling emergence and it seems unlikely that seed vigor would influence their ability to carry out physiological processes and accumulate dry matter during the whole vegetative stages of development (TeKrony & Egli, 1991).

Fontes (1998) verified that onion shows a relatively slow growth rate, at the first stage of development, followed by a rapid increase of leaf area and plant height, culminating with the bulb formation. This pattern of plant growth was observed in the present study since plants from all seed lots exhibited a slow growth during the first 28 days after seedling emergence; from the 56th to the 84th day after sowing, rapid increases in plant height followed by a decrease in growth rate were observed, indicating the first signals of the bulb formation process. The same pattern of development was exhibited by all seed lots and both cropping systems.

Plants were grown under favorable soil and environmental conditions for both crop systems and experimental years. In the second year, temperature was around 20^{o}C during seedling emergence and at the transplant time (42 days after sowing), followed by a period of temperatures around 21^{o}C and day length of 11,4 h during plant development. Bulbing started 84 days after sowing, when temperature reached mean values of 25^{o}C and photoperiod was 12,5 h as required for bulb production.

Plant dry weight did not show significant increases from seedling emergence up to the 56th day; those became more intense as the bulb formation process started. It is therefore appropriate to state that onion plants intensify dry matter accumulation after bulb differentiation. This observation is in accordance to Shadbolt & Holm (1956) and Wicks *et al*. (1973), who reported a limited photosynthetic capacity of onion during the initial plant development.

The pattern of onion plant development herein observed demonstrated that the effects of seed vigor differences detected by laboratory tests were related to the initial plant growth (first 56 days), in the second year

Table 5. Yield and bulb characteristics from six onion seed lots, cv. Petroline, in 2000/2001 field study, for the direct sowing and the transplant cropping systems. Piracicaba, USP/ESALQ, 2001.

Seed lots	Direct sowing				Transplant			
	Number of bulbs	Bulb characteristics		Yield	Number of bulbs	Bulb characteristics		Yield
		Diameter	Fresh Weight			Diameter	Fresh Weight	
	(bulbs/m²)	(cm)	(g)	(t/ha)	(bulbs/m²)	(cm)	(g)	(t/ha)
1	50.00 a*	54.89 a	91.74 a	45.90 a	63.33 a*	55.70 a	106.40 a	67.40 a
2	32.50 a	52.19 a	85.27 a	27.70 a	62.50 a	49.49 a	77.11 a	48.20 a
3	49.17 a	52.41 a	88.59 a	43.60 a	66.67 a	50.31 a	85.71 a	57.10 a
4	38.33 a	52.95 a	89.44 a	34.30 a	62.50 a	52.56 a	85.33 a	53.30 a
5	43.75 a	57.54 a	105.36 a	46.10 a	63.33 a	51.91 a	88.82 a	56.30 a
6	45.00 a	54.84 a	94.40 a	42.50 a	55.00 a	52.33 a	88.29 a	48.60 a
CV%	21.4	6.8	14.9	24.8	13.5	11.8	25.0	25.5

*/ Mean comparison within each column (Tukey's test, $p < 0.05$).

experiment. This fact was attributed to the occurrence of wider differences in seed physiological potential in comparison to those determined in the first year.

Variation in germination percentage among seed lots was overcome by adjusting seed sowing rates to obtain a uniform stand of 14 plants/m. Therefore, in the absence of population differences, a wider variation in seed vigor in the second year was associated to the initial plant development in field conditions. This information confirmed the findings of Burris (1976), Stradioto-Neto *et al*. (1992) and Piana *et al*. (1995a). However, this influence did not persist over time since there were no significant differences in bulb characteristics and plant yield from all six seed lots evaluated, in both crop systems. The same was observed by Lingegowda & Andrews (1973) for cabbage and Ellis (1992) for lettuce. Burris (1976) emphasized that beyond differences in initial growth, unless very large variation exists among seed lots, differences in yield usually do not occur or are not significant.

Finch-Savage & McKee (1990) reported that differences in transplant uniformity due to seed physiological potential had little impact of agronomic significance following transplanting. This means that even when wide differences in seed vigor are observed the selection of seedlings for transplants contribute to diminish possible variation associated to seed quality. As a consequence, the direct sowing system increases the possibility of extending the effects of seed vigor on plant performance. However, in this study there were only non-significant trends for higher yield from higher quality seed lots (Table 5). Carvalho (1986) mentioned that the influence of seed vigor on plant performance in the field occurs during the initial development and diminishes over time as plants reach subsequent growth stages. This was shown by the results of our second year experiment. In addition, Burris (1976) mentioned that quite often, to achieve large enough differences in vigor to show positive effects, the low-vigor seed lots used are far below market standards as determined by the standard germination test. Use of such seed lots represents mainly an academic approach but contributes little to elucidate the expected influence of seed vigor on field performance.

Finally, the results obtained showed that the initial plant development as measured by plant height and dry matter accumulation was influenced by onion seed vigor but these effects did not persist during plant vegetative growth and yield was not affected. It was therefore concluded that the use of high vigor seed lots is justifiable to ensure adequate stand establishment under different environmental conditions, as emphasized in seed vigor definition (Marcos Filho, 1999).

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