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Comparison of lots of pea seeds produced in northwest of Paraná

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Abstract: The establishment of the crop demands the use of seeds that allow the plants to perform better in adverse conditions. The study aimed to compare lots of pea seeds produced in the northwestern region of Paraná. The experiment was carried out in a completely randomized design with seven seed lots and four replications. The seeds were obtained in field production, with similar management conditions. The determination of the weight of a thousand seeds, water content, electrical conductivity, percentage of germination, fresh and dry mass of the aerial part and root of the seedlings performed. The data were subjected to analysis of variance and the means compared by the Tukey test with 5% significance. The physiological potential not directly related to the seed mass; of the pea lots produced under adverse conditions, lots L3 and L4 showed superior quality. The physiological tests of electrical conductivity and germination differentiated the quality of the seeds. According to the selection criteria, the seeds of four pea lots showed germination higher than 85%, being the seeds of the lot L3 and L4 presented superior quality.

Keywords: Germination, *Pisum sativum*, seed quality.

Comparação de lotes de sementes de ervilha produzidas no noroeste do Paraná

Resumo: O estabelecimento da cultura demanda a utilização de sementes que permitam as plantas desempenho superior em condições adversas. O estudo teve como objetivo comparar lotes de sementes de ervilha produzidas na região noroeste do Paraná. O experimento foi desenvolvido em delineamento inteiramente casualizado com sete lotes de sementes e quatro repetições. As sementes foram obtidas em produção à campo, com condições similares de manejo. Foi realizada a determinação do peso de mil sementes, teor de água, condutividade elétrica, porcentagem de germinação, massa fresca e seca da parte aérea e raiz das plântulas. Os dados foram submetidos a análise de variância e as médias comparadas pelo teste Tukey com 5% de significância. O potencial fisiológico não teve relação direta com a massa das sementes; dos lotes de ervilha produzidos em condições adversas, lotes L3 e L4 apresentaram qualidade superior. Os testes fisiológicos de condutividade elétrica e germinação diferenciaram a qualidade das sementes. Pelos critérios de seleção, as sementes de quatro lotes de ervilha apresentaram germinação superior a 85%, sendo que os lotes L3 e L4 apresentaram qualidade superior.

Palavras-chave: Germinação, *Pisum sativum*, qualidade de sementes.

Introduction

The pea belonging to the genus *Pisum*, consisting of only two species, the cultivated *Pisum sativum* L. and the wild *Pisum fulvum* (Pereira, 2019). Culture highlighted by the low cost of production, being an alternative in the winter period, by adopting water and cultural management practices it is possible to obtain high productivity and financial return (Santos et al., 2018b).

In the implantation of the crop, seed quality is fundamental to guarantee the plant stand and the productive performance (Wendt et al., 2017). Quality seeds are characterized by their ability to germinate and develop even in adverse conditions in the field, for the purpose they are influenced by genetic factors, production, harvest, processing and storage (Pinheiro et al., 2017).

To analyze the quality of seeds, in addition to the germination test, other evaluations must carried out in order to identify and differentiate high and low quality lots (Machado, 2010). In addition to the germinative potential of the seeds, environmental factors such as water and salt stress conditions reduce germination and the initial performance of the plants (Pereira et al., 2020). Thus, it is essential to characterize the germinative potential of seed lots, for the identification of high vigor seeds whose positive reflex can obtained in the yield (Bagateli et al., 2020).

The study aimed to compare the germinative potential and seedling development of seed lots of peas grown in northwestern Paraná.

Materials and methods

The study was conducted at the Post-harvest Technology laboratory at the State University of Maringá (UEM). The experiment was conducted in a completely randomized design, with seven lots of pea seed and five replications.

The material from cultivation carried out at the Technical Irrigation Center (CTI) in Maringá-PR, in NITOSSOLO VERMELHO distroférrico (Santos et al., 2018a), from May to October 2020 with seeds obtained from rural producers in the region. The harvest was carried out manually with humidity of 18±2% db (dry basis), threshed and kept in a ventilated environment and without direct incidence of sunlight to reduce humidity. Seven lots (Table 1) of seeds were analyzed with 4 replications, each sample consisting of approximately 500 g.

Table 1. Physical characteristics of pea seeds from different lots.

Lot	Color	Integument
L_1	Cream	Smooth
L_2	Cream	Smooth
L_3	Cream	Smooth
L_4	Cream	Rough
L_5	Cream	Rough
L_6	Green	Rough
L_7	Cream	Rough

The water content in the seeds was determined by the forced air circulation greenhouse method with a temperature of 105±3°C for 24 hours. The weight of a thousand seeds was determined using four repetitions of 100 seeds per sample. The electrical conductivity (EC) was determined using 50 seeds soaked in 250 mL of distilled water, maintained in BOD (Biochemical Oxygen Demand) at a temperature of 25°C for 24 hours (Machado et al., 2011).

Germination was performed as described by BRASIL (2009), on germination paper with four subsamples of 50 seeds per repetition, being kept in a germination chamber at a constant temperature of 20 ° C and with count of germinated seeds on the fifth and eighth day. In the seedlings from the germination test, the fresh and dry mass of the aerial part and roots was determined, still determining the aerial part/root mass ratio.

The data were subjected to analysis of variance and the means compared by the Tukey test with 5% significance, using the SISVAR software (Ferreira, 2019). The correlation between variables with the Excell® software was estimated.

Results and discussion

The lots of pea seeds showed significant differences ($p<0.05$) for the analyzed variables (Table 2). Regarding the physical characteristics, the mass of a thousand seeds from lots L5 and L7 was approximately 50% lower than the weight of seeds from lots L1 and L2.

Table 2. Weight of a thousand seeds, water content, electrical conductivity and germination of pea seeds from different lots grown in Maringá-PR, 2020.

Lot	Thousand seed weight (g)	Water content (% db)	Electrical conductivity (µS cm^{-1} g^{-1})	Germination (%)	
				5° day	8° day
L_1	247.36 a	12.59 b	9.17 a	75.92 b	81.48 c
L_2	234.94 a	12.53 b	20.66 c	90.00 a	93.33 ab
L_3	173.95 c	12.40 b	24.88 c	88.57 a	94.28 a
L_4	175.59 c	11.78 a	9.22 a	92.00 a	96.00 a
L_5	136.28 d	12.13 ab	24.62 c	8.00 d	88.00 b
L_6	198.08 b	12.94 b	40.55 d	10.00 d	30.00 e
L_7	122.31 d	12.61 b	15.88 b	36.00 c	42.00 d
CV (%)	25.34	3.00	52.70	66.63	36.42

*averages followed by the same letter, in the column, do not differ by the Tukey test ($p <0.05$).

The accumulation of mass in the seeds is a direct result of the cultivation conditions, reflecting genetic and nutritional factors, photosynthetic efficiency and the presence of biotic and abiotic stress during the cycle, especially when considering that in the source/drain ratio, the seed has preference in the targeting nutrients and photo assimilates (Taiz et al., 2017). In nutritional terms, the management of fertilization can change the dynamics of macro and micronutrient accumulation, even without altering productive components (Wenneck et al., 2020a).

In addition to the seed mass, the integrity of the membranes is a fundamental factor to maintain quality during storage, allowing for proper development in relation to germination and uniformity. The integrity of the membrane can be assessed through electron microscopy or EC analysis in solution. The EC is related to the concentration of ions in solution, where the high leakage of electrolytes reflects damage to the membranes, and indicates that there may be a reduction in reserves, an increase in biochemical and oxidative activity, being directly related to management in cultivation, harvest and post-harvest of the product (Saath et al., 2017; Wenneck et al., 2020b).

Low EC values indicate more integral membranes and reflect on germination (Ferreira et al., 2017). Although lot L1 has EC similar to lot L4, there are significant differences in relation to germination (Table 2), indicating that the germination process involves other factors.

However, according to Table 2, the highest EC values are related to the batch with the lowest germinative percentage (L6), corroborating that the analysis is a valid and complementary parameter for comparing batches and identifying failures during production. Damaged seeds and/or that did not reach physiological maturation (greenish) signal flaws in the production systems, which also be identified by the vigor test (Pinheiro et al., 2017).

Still, the period after harvest was short, the best germinative potential (96%) obtained in the lot (L4) with the lowest water content (11.78 %db). Seed moisture is directly related to phytosanitary quality and the germinative potential of the seed during storage (Sá et al., 2020).

Differences in the integument smooth or rough are due to the chemical composition of the seeds, especially sugars and starch, which can influence health characteristics (Santos et al., 2018b). Of the seeds with the best performance in the germination tests (Table 2), lots L2 and L3 consist of smooth seeds and L4 of rough seeds (Table 1).

Assessments associated with seed vigor allow the prediction of field behavior in adverse conditions, making it possible to understand the factors involved and adopt efficient management practices, for which technological resources must be used for differentiation of lots (Wendt et al., 2017; Pereira et al., 2020).

From the analyzed seed lots, the seedlings from lots L1, L4 and L5 showed the highest accumulation of fresh mass (FMAP). Lots L1 and L4 also showed higher accumulation of dry mass of the aerial part (DMAP), as shown in Table 3.

Table 3. Characteristics of pea seedlings from different lots grown in Maringá-PR, 2020.

Lot	FMAP	FRM	DMAP	DRM	FM AP/R	DM AP/R
L_1	228.20 a	155.68 a	16.14 a	10.89 a	1.47 b	1.48 b
L_2	119.11 d	84.93 c	7.25 c	8.04 b	1.40 b	0.90 c
L_3	151.95 c	149.52 a	18.19 a	11.14 a	1.02 c	1.63 a
L_4	222.46 a	140.23 a	16.75 a	11.69 a	1.59 b	1.43 b
L_5	184.82 b	106.77 b	11.70 b	7.70 bc	1.73 a	1.52 ab
L_6	103.53 d	89.13 c	7.67 c	7.93 bc	1.16 c	0.97 c
L_7	174.70 bc	94.58 bc	6.64 c	6.21 c	1.85 a	1.07 c
CV (%)	28.24	25.83	41.24	23.27	20.34	23.13

FMAP: fresh mass of the aerial part; FRM: fresh root mass; DMAP: dry mass of the aerial part; DRM: dry root mass; FM AP/R: List of FMAP/FRM; DM AP/R: List of DMAP/DRM.
*averages followed by the same letter, in the column, do not differ by the Tukey test ($p < 0.05$).

Considering that the seedling development allows to verify the seed potential in adverse conditions (Souza et al., 2017), it is possible to observe that lots with germination higher than 85% do not necessarily present better seedling development, as identified in lots L2 and L5 (Table 3). Even so, the association of evaluations allows selecting lots that have high germinative potential and seedling development (L4), characteristics of high relevance in the commercialization of seeds.

In relation to the accumulation of dry mass of the root and aerial part, lots L3 and L4 with higher germinative percentage (Table 2) also present higher mass accumulation, while lots L6 and L7 showed lower results for both variables.

Germination indices, seedling development and mass accumulation have the performance associated with seed size (Dubal et al., 2017; Derre et al., 2017). Although there more factors involved, considering that there was no direct relationship between germination and seed mass in lots L3 and L4.

In addition to the development of seedlings in global mass, the relationship between aerial part and root must analyzed, considering that both plant components must present full development for the success of the crop. According to the study, the germinative percentage mainly reflected in the dry matter accumulation ratio of the aerial part in relation to the root, with L3 showing a value higher than L6 (Table 3).

When analyzing the correlation of the variables, a negative correlation (-0.84) was obtained between fresh mass of the aerial part and EC, while the correlation with germination was equal to -0.61 and -0.51 on the fifth and eighth day, respectively (Table 4). These results demonstrate that the extravasation of electrolytes from the cell membrane can cause negative reflexes at different levels, both in germination potential and in seedling development.

Table 4. Correlation between analyzed variables.

	FMAP	FRM	DMA	DRM	G5	G8	H	EC	WTS	FSR	DAR
FMAP	1.00	-	-	-	-	-	-	-	-	-	-
FRM	0.70	1.00	-	-	-	-	-	-	-	-	-
DMA	0.62	0.96	1.00	-	-	-	-	-	-	-	-
DRM	0.49	0.89	0.93	1.00	-	-	-	-	-	-	-
G5	0.27	0.55	0.54	0.70	1.00	-	-	-	-	-	-
G8	0.41	0.53	0.65	0.62	0.68	1.00	-	-	-	-	-
H	-0.62	-0.41	-0.55	-0.47	-0.36	-0.72	1.00	-	-	-	-
EC	-0.84	-0.53	-0.42	-0.41	-0.61	-0.51	0.55	1.00	-	-	-
WTS	-0.08	0.21	0.15	0.41	0.49	0.23	0.30	-0.09	1.00	-	-
FSR	0.51	-0.23	-0.31	-0.44	-0.28	-0.06	-0.36	-0.52	-0.48	1.00	-
DAR	0.66	0.85	0.90	0.67	0.22	0.59	-0.57	-0.35	-0.17	-0.07	1.00

* FMAP - fresh mass of the aerial part; FRM- fresh root mass; DMA- dry mass of the aerial part; DRM- dry root mass; G5- germination on the fifth day; G8- germination on the eighth day; H- Humidity; EC- electrical conductivity; WTS- weight of a thousand seeds; FSR- fresh mass shoot/root ratio; DAR- dry mass/aerial part/root ratio.

The development of the morphological components has a correlation of 0.7 for fresh mass and 0.93 for dry mass. In addition, the correlation between moisture and germination is higher (-0.72) in the final count. Although physical factors, such as mass and dimension, considered relevant in the commercialization of seeds, due to economic and operational characteristics, the determination of lots of superior quality must base on integrity and vigor tests, to guarantee uniform at the stand and high yield productive.

Conclusions

The analyzed lots, there was no direct relationship between a thousand seed mass and physiological potential.

The seven lots evaluated, four-showed germination above 85%. However, other evaluations adopted allowed to differentiate the quality of the seed between the lots with high germination, being possible to determine that the seeds of the lot L3 and L4 presented superior quality.

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