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Number of replicates in trials for evaluating melon hybrids[1]

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ABSTRACT - During experiment planning, determining the number of replicates for tested treatments is important because it directly affects the accuracy of the obtained results. This study was conducted to determine the number of measurements (repetitions) necessary to evaluate the yield traits and soluble solids in Cantaloupe and Gália melon hybrid trials. The study comprised twenty-one experiments, nine for evaluating eight Cantaloupe melon hybrids, and twelve for evaluating nine Galia melon hybrids, conducted in a randomized complete block design with three replicates each. Analysis of variance was performed, and repeatability and genotypic determination coefficients were estimated for each experiment. The use of three repetitions allowed identification of superior genotypes with 83.6 and 80.7% predictions of the real values for the yield and soluble solids, respectively, for Cantaloupe melons. Evaluating the trials with Galia melon using three repetitions allowed prediction of the true value of the genotypes with 86.1 and 98.6% accuracy for fruit yield and soluble solids, respectively. Therefore, the use of three replicates was determined to be sufficient for detecting superior genotypes both for fruit yield and soluble solid content, with more than 80% certainty for their true values.

Key words: *Cucumis melo* L., Repeatability, Experimental planning.

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INTRODUCTION

Melon cultivation has gained great economic importance for the states in the Northeast of Brazil, especially in Rio Grande do Norte and Ceará, which are the largest producers and exporters of the fruit owing to suitable soil and climatic conditions, as well as the advanced production technology employed by producing companies (NUNES *et al*., 2011a). Consequently, breeding efforts have been made by both private and public enterprises under the climatic and cultivation conditions in these states (NUNES *et al*., 2011b).

The appropriate number of repetitions to be used is an important factor in experimental design, and determining their number has been a common question among researchers. As the number of repetitions increases, the experimental precision improves and the statistical power of the test is enhanced (CARGNELUTTI FILHO; GUADAGNIN, 2011). Therefore, determining the ideal number of repetitions for an experiment is a challenge for researchers and is often done considering the experimental costs, necessary infrastructure, and the available labor required for their execution. Further, the number of repetitions in an experiment are recommended to be sized such that a minimum of ten degrees of freedom is provided for the residual (PIMENTEL-GOMES, 2009).

Some authors have been sizing the number of repetitions to achieve a certain level of precision based on data from previously conducted genotype trials, eliminating the need for separate conducting a trial solely for this purpose (CARGNELUTTI FILHO; BRAGA JUNIOR; LÚCIO, 2012; TEODORO *et al*., 2016), This approach is feasible using the repeatability coefficient, which can be obtained through variance analysis (CRUZ; REGAZZI; CARNEIRO, 2012). This technique has also been used to determine the number of repetitions for evaluating production traits in various crops, such as soybeans (CARGNELUTTI FILHO; GONÇALVES, 2011), maize (CARGNELUTTI FILHO; STORCK; GUADAGNIN, 2010), common beans (GURGEL *et al*., 2017), cowpea (TORRES *et al*., 2015), sugarcane (CARGNELUTTI FILHO; BRAGA JUNIOR; LÚCIO, 2012; SILVA *et al*., 2018), rice (CARGNELUTTI FILHO *et al*., 2012), mangaba, a tropical fruit (PINHEIRO *et al*., 2019), and elephant grass (CAVALCANTE *et al*., 2012).

Furthermore, new statistics for precision have been proposed as a means of assessing the experimental quality and result reliability. For example, accuracy is considered suitable for evaluating the experimental precision of genotype competition trials, and experimental precision ranges were established by Resende and Duarte (2007). Studies have shown that, for cultivar competition trials, accuracy is more suitable than the coefficient of variation for assessing experimental precision (CARGNELUTTI FILHO *et al*., 2012).

However, for melon, the use of this precision statistic to evaluate the experimental quality of genotype trials is unknown, and there are no references regarding the use of the repeatability coefficient to determine the number of repetitions for this crop, especially for aromatic varieties, which are considered high-value and are experiencing significant expansion in the major production regions (CHAVES *et al*., 2014).

Therefore, this study was conducted to determine the number of measurements (repetitions) required to assess yield traits and soluble solids in Cantaloupe and Gália melon hybrids, as well as to evaluate experimental precision using selective accuracy.

MATERIALS AND METHODS

Data from twenty-one field experiments were used in this study. Nine experiments involving eight cantaloupe melon hybrids were conducted at three different locations over three consecutive years. Twelve experiments were conducted for the Gália cultivar (across four locations over three consecutive years) with nine hybrids. All trials were conducted in municipalities within the Agropolo Mossoró-Assu, located in the state of Rio Grande do Norte, which is the main production and export hub for melons in Brazil.

The trials were conducted using a randomized complete block design with three repetitions. Each plot comprised two rows of five meters, spaced at 2.0 x 0.5 meters, totaling 20 plants per plot, with the plants at the ends considered as border plants. Cultural practices, such as the application of agricultural pesticides and weeding, were carried out as required for the crop following the recommended management and standard cultural practices for melon cultivation in the state of Rio Grande do Norte (NUNES *et al*., 2011a).

The evaluated traits included commercial yield and soluble solid content in fruits, which are considered by producers as the most important traits from a commercial perspective. The commercial yield was determined by weighing all commercial fruits harvested from the plot. Total soluble solid content was measured by taking a sample from approximately 2/3 of the pulp thickness in the equatorial region of the fruit towards the cavity. The sample was manually pressed until some of the juice was deposited onto a digital refractometer (Digital Refractometer Palette 100®), allowing measurement of the soluble solids content. To measure the soluble solid content, eight fruits per plot were sampled.

For each experiment, an analysis of variance was conducted at a nominal significance level α = 0.05, using the statistical model y = Xr + Zg + e, where y is the data vector, r is the vector of repetition effects (assumed fixed) added to the overall mean, g is the vector of genotypic effects (assumed random), and e is the vector of errors or residuals (random). Uppercase letters represent incidence matrices (RESENDE, 2007).

Estimates of the mean squares of the blocks were obtained from the ANOVA results. (MS_B) of the mean square of genotype (MS_G), mean square of error (MS_E), and F-test value for the genotype $(F_G = MS_G / MS_E)$. Additionally, the overall mean of the experiment (m) and coefficient of variation were calculated $\left(CV = 100\sqrt{MS_E / m}\right)$. Subsequently, selective accuracy (SA) was estimated using the expression $SA = \sqrt{1 - \frac{1}{F_G}}$. Based on the SA values, experimental precision was evaluated according to the class limits established by Resende and Duarte (2007).

The evaluations within each block were treated as measurements of the same individual (genotype), and the repeatability coefficient (r) was estimated for each trait and experiment using analysis of variance. In this study, the repeatability coefficient corresponded with the intraclass correlation coefficient for the genotypes and was estimated using the expression $r = \frac{(MS_G - MS_E)/J}{(MS_G - MS_E)/J + MS_E}$, where J refers to the number of measurements or repetitions (CRUZ; REGAZZI; CARNEIRO, 2012).

The number of measurements or repetitions (J) required to predict the true values of individuals (genotypes) based on pre-established genotypic determination coefficients (R^2) (0.50; 0.55; 0.60; 0.65; 0.70; 0.75; 0.80; 0.85; 0.90; 0.95) was calculated using the expression $J = \frac{R^2(1-r)}{(1-R^2)r}$ (CRUZ; REGAZZI; CARNEIRO, 2012). The genotypic determination coefficient (R^2), which represents the certainty of predicting the true values of the selected genotypes based on J measurements, was obtained using the expression $R^2 = \frac{Jr}{1 + r(J-1)}$, where J is the number of measurements conducted (J = 3 blocks in this study), and r is the repeatability coefficient (CRUZ; REGAZZI; CARNEIRO, 2012).

Based on the repeatability coefficient (r) between experiments conducted for each type of melon and each trait, the genotypic determination coefficient (R^2) was calculated for different numbers of repetitions (J ranging from 0 to 50). Although experiments with zero repetitions have no practical sense and experiments with 50 repetitions are practically unfeasible, these limits were chosen to demonstrate the relationship between R^2 and J based on a fixed value of r (r = average of the trials for each type of melon). Statistical analyses were conducted using SELEGEN (RESENDE, 2007) and Microsoft Office Excel software.

RESULTS AND DISCUSSION

Cantaloupe Melon

Of the 18 cases evaluated for yield and soluble solid content (Table 1), a significant blocking effect was observed in 33% of the experiments. For soluble solids, a significant block effect was observed in approximately 78% of the trials, indicating that the blocks were heterogeneous in these cases and that the experimental design was efficient at controlling this source of heterogeneity.

Table 1 - Summary of the analysis of variance containing degrees of freedom and mean square (QM) for sources of variation, mean, experimental coefficient of variation (CV), F-test value for genotype (F_G), selective accuracy (SA), and experimental precision(1) for

Trial	MS (ANOVA)			Mean	CV (%)	FG	SA	Precision1
	Block (2)	Genotype (7)	Error (14)					
				Yield (t ha^{-1})				
1	16.642^{ns}	43.803^{ns}	43.516	27.678	23.834	1.007	0.081	Low
2	2.181^{ns}	235.143*	23.137	22.932	20.976	10.163	0.950	Very high
3	53.630*	242.133*	3.131	25.273	7.001	77.334	0.994	Very high
4	59.778*	107.197*	4.551	27.952	7.632	23.555	0.979	Very high
5	55.018*	233.340*	13.985	29.746	12.572	16.685	0.970	Very high
6	11.593^{ns}	261.968*	11.130	22.947	14.538	23.538	0.979	Very high
7	22.591^{ns}	88.332^{ns}	44.825	25.018	26.761	1.971	0.702	High
8	3.560^{ns}	113.298*	29.061	22.289	24.186	3.899	0.862	High
9	3.907^{ns}	140.732*	24.554	29.046	17.060	5.732	0.909	Very high

Continuation Table 1

Soluble solids (° Brix)								
1	8.0743*	8.7291*	2.116	9.785	14.867	4.125	0.870	High
2	9.5202*	4.5734*	1.153	9.146	11.738	3.968	0.865	High
3	5.2255*	5.3381*	1.098	9.792	10.701	4.862	0.891	High
4	5.8981*	17.6351*	1.586	11.176	11.270	11.116	0.954	Very high
5	6.4181*	5.7554*	1.066	9.280	11.126	5.399	0.903	Very high
6	6.5101*	6.3302*	1.593	9.367	13.474	3.974	0.865	High
7	9.9072*	11.2056*	0.642	9.693	8.264	17.465	0.971	Very high
8	1.2854^{ns}	3.6469*	1.384	6.721	17.503	2.636	0.788	High
9	5.1588^{ns}	8.5262*	1.550	9.204	13.528	5.499	0.905	Very high

1: Class limits established by Resende and Duarte (2007): Very high (SA ≥ 0.90), High (0.70 ≤ SA < 0.90), Moderate (0.50 ≤ SA < 0.70), and

A significant effect of genotype was observed in 16 of the 18 evaluated cases. For yield, a significant genotype effect was observed in seven of the nine cases assessed, and for these cases, the average values for F_G, SA, r, and R^2, based on three repetitions, were 22.9864, 0.9486, 0.7748, and 0.9018, respectively. In cases where no significant effect was observed, the average values of F_G, SA, r, and R^2 were 1.4886, 0.3914, 0.1233, and 0.2495, respectively. For soluble solids, a significant genotype effect was observed in all evaluated cases, with average values of 6.5605, 0.8902, 0.5814, and 0.7961 obtained for F_G, SA, r, and R^2, respectively.

Although Resende and Duarte (2007) recommended a minimum of six repetitions for evaluating production traits and suggested that using two to four repetitions would not allow achieving ideal levels of selective accuracy; this study revealed that using three repetitions resulted in average values for this precision statistic, exceeding 0.80, both for yield and soluble solids. Other studies have demonstrated similar results, in which even with relatively lower number of repetitions than six, achieving high experimental precision in various crops was possible (CARGNELUTTI FILHO; GONÇALVES, 2011; TORRES *et al*., 2015).

The average coefficient of variation (CV) varied depending on the evaluated trait and, according to Lima, Nunes, and Bezerra Neto (2004), it was classified as medium for both yield (13.4 < CV ≤ 42.98), and soluble solids (8.47 < CV ≤ 15.45), with relatively lower values obtained for the latter trait, as expected for the characteristics measured in the laboratory compared with those in the field (LIMA; NUNES; BEZERRA NETO, 2004).

Based on the average values observed for the precision statistics, the higher the experimental precision, the more easily a significant genotype effect was observed, whereas the absence of a genotypic effect in the trials was associated with low experimental precision, as evidenced by the very low selective accuracy values.

Considering all cases, the values for selective accuracy ranged from 0.0810 (Trial 1) to 0.9935 (Trial 3), both observed for yield, with an average of 0.8575. Of the 18 cases evaluated, 10 were considered to have very high experimental precision, seven had high precision, and only one had low precision (Table 1). Therefore, variability was observed in the experimental precision among traits and trials, and overall, these traits were evaluated under satisfactory experimental conditions.

The repeatability coefficient values ranged from 0.0022 to 0.9622 regardless of the evaluated trait or experiment. Genotypic determination coefficients ranged from 0.0066 to 0.9871 (Table 2). The variability in r among traits and trials was significant, representing different real situations; this allowed for inferences regarding the number of repetitions in general applications.

The average value of the repeatability coefficient (r) for the nine trials with Cantaloupe melon hybrids was 0.6300 for yield and 0.5814 for soluble solids. The estimate of the genotypic determination coefficient (R^2), based on the average value of r, ranged from 0.8363 (yield) to 0.8065 (soluble solids), indicating that three replicates allowed for the detection of genotypic differences with 83.63% and 80.65% certainty in predicting the actual genotype values for yield and soluble solids, respectively (Table 2).

Trials with other crops have also achieved a selective accuracy goal of 90%, corresponding to a genotypic determination coefficient of 81%, even when adopting a relatively lower number of repetitions than the six repetitions theoretically recommended by Resende and Duarte (2007). This phenomenon has been observed in crops such as rice (CARGNELUTTI FILHO *et al*., 2012), maize (CARGNELUTTI FILHO; STORCK; GUADAGNIN, 2010), cowpea (TORRES *et al*., 2015), and *Jatropha curcas* (TEODORO *et al*., 2016); however, the use of a greater number of repetitions should be encouraged to maximize experimental precision.

Table 2 - Estimates of repeatability coefficients (r), genotypic determination coefficients (R^2), and the number of measurements (repetitions) (J)(1) associated with different R^2 values for yield and soluble solids of eight Cantaloupe melon hybrids evaluated in nine experiments

Statistic	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Average r
Yield (t ha^{-1})										
r	0.0022	0.7534	0.9622	0.8826	0.8394	0.8825	0.2444	0.4914	0.6120	0.6300
R^2	0.0066	0.9016	0.9871	0.9575	0.9401	0.9575	0.4925	0.7435	0.8255	0.8363
J Estimated										
R^2 = 0.50	454.08	0.33	0.04	0.13	0.19	0.13	3.09	1.03	0.63	0.59
R^2 = 0.55	554.98	0.40	0.05	0.16	0.23	0.16	3.78	1.26	0.77	0.72
R^2 = 0.60	681.12	0.49	0.06	0.20	0.29	0.20	4.64	1.55	0.95	0.88
R^2 = 0.65	843.29	0.61	0.07	0.25	0.36	0.25	5.74	1.92	1.18	1.09
R^2 = 0.70	1059.52	0.76	0.09	0.31	0.45	0.31	7.21	2.41	1.48	1.37
R^2 = 0.75	1362.23	0.98	0.12	0.40	0.57	0.40	9.27	3.10	1.90	1.76
R^2 = 0.80	1816.31	1.31	0.16	0.53	0.77	0.53	12.36	4.14	2.54	2.35
R^2 = 0.85	2573.11	1.86	0.22	0.75	1.08	0.75	17.52	5.86	3.59	3.33
R^2 = 0.90	4086.70	2.95	0.35	1.20	1.72	1.20	27.82	9.31	5.71	5.29
R^2 = 0.95	8627.48	6.22	0.75	2.53	3.63	2.53	58.73	19.66	12.05	11.16
Soluble solids (°Brix)										
r	0.5102	0.4973	0.5628	0.7713	0.5945	0.4978	0.8459	0.3528	0.6000	0.5814
R^2	0.7576	0.7480	0.7943	0.9100	0.8148	0.7484	0.9427	0.6206	0.8182	0.8065
J estimated										
R^2 = 0.50	0.96	1.01	0.78	0.30	0.68	1.01	0.18	1.83	0.67	0.72
R^2 = 0.55	1.17	1.24	0.95	0.36	0.83	1.23	0.22	2.24	0.81	0.88
R^2 = 0.60	1.44	1.52	1.17	0.44	1.02	1.51	0.27	2.75	1.00	1.08
R^2 = 0.65	1.78	1.88	1.44	0.55	1.27	1.87	0.34	3.41	1.24	1.34
R^2 = 0.70	2.24	2.36	1.81	0.69	1.59	2.35	0.43	4.28	1.56	1.68
R^2 = 0.75	2.88	3.03	2.33	0.89	2.05	3.03	0.55	5.50	2.00	2.16
R^2 = 0.80	3.84	4.04	3.11	1.19	2.73	4.03	0.73	7.34	2.67	2.88
R^2 = 0.85	5.44	5.73	4.40	1.68	3.86	5.72	1.03	10.39	3.78	4.08
R^2 = 0.90	8.64	9.10	6.99	2.67	6.14	9.08	1.64	16.51	6.00	6.48
R^2 = 0.95	18.24	19.20	14.76	5.63	12.96	19.17	3.46	34.85	12.67	13.68

(1): Estimates less than 1 should be interpreted as 1

Galia Melon

Twenty-four cases (12 experiments and two traits) were evaluated in nine Galia-type melon hybrids, and a significant block effect was observed in 41.7% of the cases for yield and in 100% of the cases for soluble solids (Table 3), confirming the need to work with this type of design to control the effect of this source of heterogeneity.

For yield, the genotype effect was significant in 75% of the cases, and in these, the average values for F_G, SA, r, and R^2, based on three repetitions, were 58.0515, 0.9611, 0.8298 and 0.9257, respectively. In cases where no significant genotype effect was observed, the average values for F_G, SA, r, and R^2 were 1.9059, 0.5350, 0.2077, and 0.3850, respectively. According to the class limits established by Resende and Duarte (2007), cases demonstrating a significant genotype effect were considered to have very high experimental precision, whereas cases without a significant genotypic effect were considered to have moderate experimental precision. Therefore, the failure to discriminate genotypes through the F-test in the analysis of variance in these cases may be attributed to lower experimental precision.

Table 3 - A summary of the analysis of variance, including degrees of freedom and mean square (MS) for sources of variation, mean, experimental coefficient of variation (CV), genotype F-test (F_G), selective accuracy (SA), and experimental precision[(1)] for yield and soluble solids of nine Galia melon hybrids evaluated in 12 experiments is as follows

Trial	MS (ANOVA)			Mean	CV (%)	FG	SA	Precision[1]
	Block (2)	Genotype (8)	Error (16)					
Yield (t ha^{-1})								
1	7.156^{ns}	26.139^{ns}	25.921	27.509	18.508	1.008	0.091	Low
2	92.780*	196.186*	8.148	29.269	9.752	24.079	0.979	Very high
3	10.082^{ns}	111.156*	25.514	28.925	17.463	4.357	0.878	High
4	70.697*	110.979*	1.921	28.108	4.931	57.774	0.991	Very high
5	8.227^{ns}	95.864*	21.349	22.916	20.163	4.490	0.882	High
6	9.159^{ns}	48.294^{ns}	19.211	24.982	17.545	2.514	0.776	High
7	26.770^{ns}	75.703^{ns}	34.483	24.231	24.235	2.195	0.738	High
8	57.026*	203.365*	0.950	25.592	3.809	213.978	0.998	Very high
9	97.498*	128.489*	6.630	27.605	9.327	19.381	0.974	Very high
10	8.647^{ns}	204.804*	10.683	23.424	13.954	19.171	0.974	Very high
11	10.825^{ns}	216.158*	9.219	22.794	13.321	23.448	0.978	Very high
12	23.795*	165.460*	1.062	23.596	4.368	155.785	0.997	Very high
Soluble solids (° Brix)								
1	5.930*	5.162*	0.113	9.596	3.508	45.561	0.989	Very high
2	5.714*	5.622*	0.052	9.244	2.476	107.296	0.995	Very high
3	4.287*	5.435*	0.113	9.030	3.723	48.100	0.990	Very high
4	7.218*	13.238*	0.285	11.563	4.619	46.416	0.989	Very high
5	2.258*	2.015*	0.027	6.541	2.508	74.896	0.993	Very high
6	5.996*	10.085*	0.112	10.248	3.269	89.882	0.994	Very high
7	5.480*	9.259*	0.187	10.148	4.261	49.514	0.990	Very high
8	5.385*	4.616*	0.090	9.793	3.060	51.408	0.990	Very high
9	6.100*	3.900*	0.063	10.170	2.474	61.615	0.992	Very high
10	6.012*	2.620*	0.013	9.252	1.218	206.299	0.998	Very high
11	5.317*	3.238*	0.039	9.370	2.099	83.664	0.994	Very high
12	1.978*	21.497*	0.084	6.659	4.352	255.916	0.998	Very high

1: Class limits established by Resende and Duarte (2007): Very high (SA ≥ 0.90), High (0.70 ≤ SA < 0.90), Moderate (0.50 ≤ SA < 0.70), and Low (SA < 0.50). * Significant effect in the F-test at the 5% probability level. ^{ns}: Not significant

For Galia melon, similar to the observation in Cantaloupe melons, the average coefficients of variation (CVs) varied depending on the trait evaluated and were classified as low (LIMA; NUNES; BEZERRA NETO, 2004), both for yield (CV ≤ 13.4) and soluble solids (CV ≤ 8.47).

The selective accuracy (AS), regardless of the evaluated trait, ranged from 0.0912 (productivity, Trial 1) to 0.9980 (soluble solids, Trial 12). In relation to the class limits established by Resende and Duarte (2007), 19 of the 24 evaluated cases showed very high experimental precision (SA ≥ 0.90), four had high precision (0.70 ≤ AS < 0.90) and 1, had low experimental precision (AS < 0.50). This indicates variability in experimental precision between traits and trials, highlighting the need for specific experimental designs for each trial (BENIN *et al*., 2013).

The estimated repeatability coefficient (r) varied between 0.0028 and 0.9884 regardless of the trait or trial. The determination coefficient (R^2) values range from 0.0083 to 0.9855 (Table 4). The average values of r were 0.6742 and 0.9578 for yield and soluble solids, respectively. Variability in the value of r and, consequently, in estimating the number of repetitions (J) between traits, was also observed in cowpea (TORRES *et al*., 2015) and soybean (CARGNALUTTI FILHO; GONÇALVES, 2011).

Table 4 - Estimates of repeatability coefficients (r), genotypic determination coefficients (R^2), and number of measurements (repetitions) (J)[1] associated with different R^2 values for yield and soluble solids of nine Galia melon hybrids evaluated in 12 experiments are as follows

Statistic	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10	Trial 11	Trial 12	Average r
	Yield (t ha^{-1})												
r	0.0028	0.8850	0.5281	0.9498	0.5378	0.3354	0.2849	0.9861	0.8597	0.8583	0.8821	0.9810	0.6742
R^2	0.0083	0.9585	0.7705	0.9827	0.7773	0.6022	0.5445	0.9953	0.9484	0.9478	0.9574	0.9936	0.8613
	J estimated												
R^2 = 0.50	357.54	0.13	0.89	0.05	0.86	1.98	2.51	0.01	0.16	0.17	0.13	0.02	0.48
R^2 = 0.55	436.99	0.16	1.09	0.06	1.05	2.42	3.07	0.02	0.20	0.20	0.16	0.02	0.59
R^2 = 0.60	536.30	0.19	1.34	0.08	1.29	2.97	3.76	0.02	0.24	0.25	0.20	0.03	0.72
R^2 = 0.65	663.99	0.24	1.66	0.10	1.60	3.68	4.66	0.03	0.30	0.31	0.25	0.04	0.90
R^2 = 0.70	834.25	0.30	2.09	0.12	2.01	4.62	5.86	0.03	0.38	0.39	0.31	0.05	1.13
R^2 = 0.75	1072.61	0.39	2.68	0.16	2.58	5.95	7.53	0.04	0.49	0.50	0.40	0.06	1.45
R^2 = 0.80	1430.14	0.52	3.58	0.21	3.44	7.93	10.04	0.06	0.65	0.66	0.53	0.08	1.93
R^2 = 0.85	2026.03	0.74	5.06	0.30	4.87	11.23	14.22	0.08	0.92	0.94	0.76	0.11	2.74
R^2 = 0.90	3217.82	1.17	8.04	0.48	7.74	17.84	22.59	0.13	1.47	1.49	1.20	0.17	4.35
R^2 = 0.95	6793.17	2.47	16.98	1.00	16.33	37.65	47.68	0.27	3.10	3.14	2.54	0.37	9.18
	Soluble solids (°Brix)												
R	0.9369	0.9726	0.9401	0.9380	0.9610	0.9673	0.9418	0.9438	0.9528	0.9856	0.9650	0.9884	0.9578
R^2	0.9781	0.9907	0.9792	0.9785	0.9866	0.9889	0.9798	0.9805	0.9838	0.9952	0.9880	0.9961	0.9855
	J estimated												
R^2 = 0.50	0.07	0.03	0.06	0.07	0.04	0.03	0.06	0.06	0.05	0.01	0.04	0.01	0.04
R^2 = 0.55	0.08	0.03	0.08	0.08	0.05	0.04	0.08	0.07	0.06	0.02	0.04	0.01	0.05
R^2 = 0.60	0.10	0.04	0.10	0.10	0.06	0.05	0.09	0.09	0.07	0.02	0.05	0.02	0.07
R^2 = 0.65	0.13	0.05	0.12	0.12	0.08	0.06	0.11	0.11	0.09	0.03	0.07	0.02	0.08
R^2 = 0.70	0.16	0.07	0.15	0.15	0.09	0.08	0.14	0.14	0.12	0.03	0.08	0.03	0.10
R^2 = 0.75	0.20	0.08	0.19	0.20	0.12	0.10	0.19	0.18	0.15	0.04	0.11	0.04	0.13
R^2 = 0.80	0.27	0.11	0.25	0.26	0.16	0.14	0.25	0.24	0.20	0.06	0.15	0.05	0.18
R^2 = 0.85	0.38	0.16	0.36	0.37	0.23	0.19	0.35	0.34	0.28	0.08	0.21	0.07	0.25
R^2 = 0.90	0.61	0.25	0.57	0.59	0.37	0.30	0.56	0.54	0.45	0.13	0.33	0.11	0.40
R^2 = 0.95	1.28	0.54	1.21	1.26	0.77	0.64	1.17	1.13	0.94	0.28	0.69	0.22	0.84

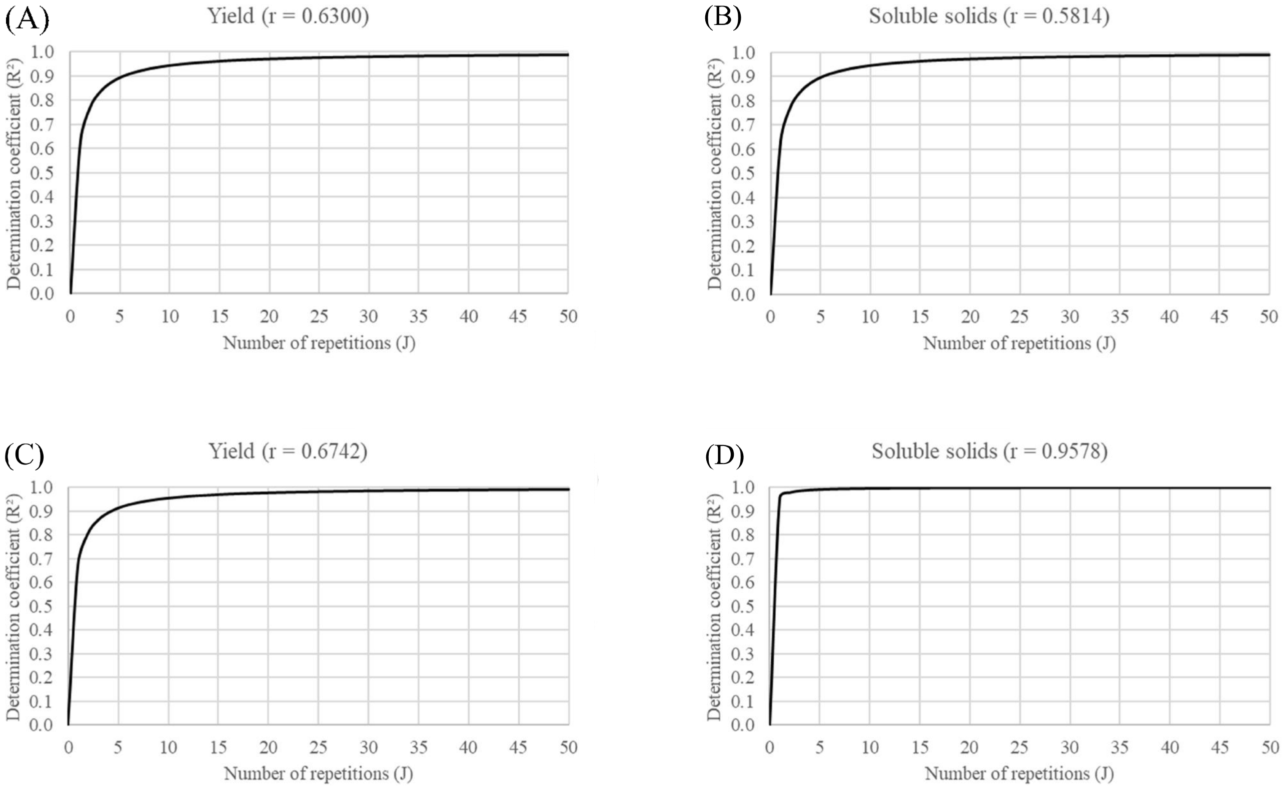
(1): Estimates less than 1 should be interpreted as 1

The estimated genotypic determination coefficients from the average r values were 0.8613 for yield and 0.9855 for soluble solids (Table 4). Therefore, genotypic differences could be detected with 86.13% and 98.55% certainty in predicting the actual genotype values for yield and soluble solids, respectively, using three replicates. Trials with R^2 values exceeding 80% were used because they represented a high level of experimental precision (CARGNELUTTI FILHO *et al*., 2012).

From the average value of the repeatability coefficient, variations in the genotypic determination coefficient could be observed as the number of repetitions increased for trials with Cantaloupe and Galia melons (Figure 1). The repeatability coefficient varied depending on the melon type and trait evaluated, which was expected because repeatability varied with the nature of the trait, genetic properties of the population, and the environmental conditions under which individuals were maintained (CRUZ; REGAZZI; CARNEIRO, 2012).

In this study, increases in R^2 from three repetitions (J = 3) were observed to be insignificant, leading to negligible improvements in predicting the actual genotype value (Figure 1). Higher repeatability coefficient values for the trait indicated the possibility of predict the actual individual values with a relatively small number of repetitions, suggesting that there would be little gain in accuracy with an increase in the number of measurements (MANFIO *et al*., 2011).

Figure 1 - Estimation of genotypic determination coefficients (R²) as a function of the number of measurements/repetitions (J), based on the average repeatability coefficient (r) of nine trials with eight Cantaloupe melon hybrids (A and B) and 12 trials with nine Galia melon hybrids (C and D)



The precision of an experiment can always be enhanced using additional repetitions; however, when repeatability is high, increasing the number of measurements yields little gain in precision (MATSUO *et al*., 2012); this happens because the increase in genotypic determination coefficient (R^2) with an increase in the number of repetitions (J) does not occur in a linear manner. Beyond a certain number of repetitions, the increase in the genotypic determination coefficient is negligible, resulting in a negligible gain in predicting the actual value of the cultivar (CARGNELUTTI FILHO; GUADAGNIN, 2011).

CONCLUSIONS

1. The repeatability coefficient varied depending on the type of melon and the trait evaluated, allowing prediction of the actual genotype value with over 80% certainty for yield and soluble solids in both the Cantaloupe and Galia types, with the use of three repetitions;
2. Increasing the number of repetitions beyond three for the evaluation of these melon types is not justified because it will result in negligible gains in predicting the actual genotype values.

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