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Implications of plant survival in the quality of experiments to evaluate progenies of the genus *Corymbia*

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ABSTRACT. The evaluation of *Corymbia maculata* and *C. torelliana* progenies has received much attention in Brazil in the last decade. For the process to be efficient, experiments must be as precise as possible. Factors that affect accuracy include plant survival (PS) and assessment age. The objectives of this study were to determine whether there are differences in progeny PS among evaluation sites and ages, whether dominated plants affect precision estimates, and how potential damage caused by differences in PS can be mitigated. Data from the evaluation of half-sib progenies of *C. maculata* at three sites and *C. torelliana* at four sites were used. The experiments were implemented in an alpha-lattice design with 40 repetitions and a single-tree plot (STP). Diameter at breast height (DBH) and PS data were obtained at three and six years of age. All plants that presented DBH with a deviation below the mean (dominated plants) were not considered in the survival estimates. Although there was a difference in plant survival between progenies and experiments, none of the strategies used to mitigate damage due to differences in PS significantly changed the classification of progenies or the magnitude of the accuracy. There was a high association between the estimates obtained at three and six years of age, indicating that for species of the genus *Corymbia*, early selection is viable.

Keywords: quantitative genetics; *Corymbia* breeding; experimentation; plant breeding.

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Introduction

Much of the success of eucalyptus cultivation in Brazil has been due to recurrent selection (RS) performed for several decades. Initially, mass selection occurred in populations of some introduced species, starting in the early 20th century, and later, half-sib (HS) or full-sib (FS) progenies were used (Ferreira, 2015). Recurrent selection (RS) involves three steps: obtaining the base population, evaluating the plants/progenies and recombining the best ones (Rutkoski, 2019). Of these three stages, the identification of plants/progenies is the one that demands the most attention. This is because, when the procedure is not performed efficiently, individuals whose phenotypes do not have the best genotypes among those evaluated in the population are recombined. Thus, there is an enormous loss of time and resources, especially in the case of perennial plants.

For genotypically superior individuals to be chosen, progeny evaluation experiments must have greater accuracy, that is, the greatest possible experimental precision. Several factors can affect the experimental precision. The differences in plant survival (PS) among the evaluated progenies stand out. When there is an experimental plot with more than one plant, the differences in the number of plants within the plot have been the subject of numerous studies on annual plants (Ramalho et al., 2012; Silva et al., 2014) and perennial species such as *Eucalyptus* genus and other forest species (Ferreira et al., 2020).

However, experiments on perennial species with a single tree plot (STP) have become very common. In principle, the consequences of differences in survival are more difficult to mitigate. This is because each plant loss should affect the difference in precision with which the mean of each progeny is obtained. When analysing the data with the mixed models (MM) method, the effects of imbalances are expected to attenuate (Bernardo, 2020; Resende, 2015).

In recent decades, the search for new species of perennial plants in Brazil has intensified to provide more options for wood production to meet the growing cellulose and charcoal demand. Among these species, those of the genus *Corymbia* have received more attention due to the quality of the wood and greater tolerance to some biotic and abiotic factors than the *Eucalyptus* species that are currently being used (Reis et al., 2014a; Reis et al., 2014b; Silva et al., 2022; Araujo et al., 2021).

Among these new species, such as *C. torelliana* and *C. maculata,* progeny evaluation has been conducted at several sites across the country. However, there is no information on the consequences of possible differences in the mean percentage survival between progenies, especially on their effect, which causes an imbalance in experimental accuracy. Additionally, because it is a species domesticated under cultivation conditions in Brazil, great variability is expected, especially for the growth traits among plants of the same progeny. Under these conditions, the differential occurrence of dominated plants, for example, those with one or more standard deviations below the mean, in experiments in STP with respect to accuracy is still unknown. Some information in this regard already exists for eucalyptus progenies and clones used in Brazil (Ferreira et al., 2020; Santos et al., 2021). Furthermore, as this species is domesticated under cultivation conditions different from those in Brazil, great variability is expected, especially in terms of growth traits between plants of the same progeny. Under these conditions, the effect of the differential occurrence of dominated plants is not yet known. For example, dominated plants are considered those with one or more standard deviations below the mean. Some information in this regard already exists for eucalyptus progenies and clones used in Brazil (Ferreira et al., 2020; Santos et al., 2021).

Thus, using data from progeny evaluation experiments of *C. torelliana* and *C. maculata* conducted at several sites in Brazil in the STP, this study was conducted with the objective of verifying whether there are differences in the PS of the progenies between the sites and ages of evaluation and whether the dominated plants affect the estimates of accuracy and additionally discussing how the possible damage caused by differences in PS can be mitigated.

Material and methods

The data used here were obtained from the evaluation of *C. maculata* and *C. torelliana* progenies and eucalyptus clones; the data were kindly provided by the company Suzano S.A. The seven experiments were implemented in 2014 in the states of Bahia, Espírito Santo, and São Paulo (Table 1).

Table 1. Characterization of the sites at which the tests were performed.

Site	Experiment	Code	Mean annual precipitation (mm)	Altitude (m)	Soil Type
Bahia	ARA.14.MG2.010	Site 1	1187	72	Argisol
	ARA.14.MG2.012	Site 2	1188	73	Argisol
	ARA.14.MG2.013	Site 3	944	82	Argisol
Espírito Santo	ARA.14.MG2.014	Site 4	1159	25	Oxisol
	ARA.14.MG2.015	Site 5	1159	24	Oxisol
São Paulo	SUL.14.MG6.037	Site 6	1214	681	Oxisol
	SUL.14.MG6.038	Site 7	1214	687	Oxisol

The experiments involved varying numbers of progenies and clones (Table 2), which were composed of progenies of *C. maculata* (sites 1, 5, and 7) and *C. torelliana* (sites 2, 3, 4, and 6). All the experiments included commercial clones of the genus *Eucalyptus* as controls.

Table 2. Planting date, spacing, number of progenies/clones, sites and species.

Code	Planting Date	Spacing (m)	Number of treatments	Number of progenies	Progeny species
Site 1	11/05/2014	3 x 3	70	64	*C. maculata*
Site 2	11/05/2014	3 x 3	72	65	*C. torelliana*
Site 3	11/26/2014	3 x 2,5	72	57	*C. torelliana*
Site 4	12/19/2014	3 x 2	72	64	*C. torelliana*
Site 5	12/19/2014	3 x 2	70	64	*C. maculata*
Site 6	11/18/2014	3 x 2	72	65	*C. torelliana*
Site 7	11/19/2014	3 x 2	70	64	*C. maculata*

The experiments were implemented in an alpha-lattice design with 40 repetitions (number of plants per progenies/site) and a single tree plot (STP). The spacing varied according to the site (Table 2), and crop management was traditionally used by the company. The diameter at breast height (DBH) in centimeters was measured at three and six years after planting.

The DBH data were subjected to analysis of variance using linear mixed models. As the efficiency of the lattice was low, analyses were performed in randomized blocks.

The percentage of plant survival (PS) was obtained at the same ages as DBH by the equation $PS = [(40 - \text{number of repetitions of each treatment})/40] \times 100$. The percentage of plants was also obtained without considering the occurrence of dominated plants. That is, all plants that presented a DBH one deviation below the mean were not considered in survival estimates generated by the same estimator presented previously. The data without elimination of dominated plants were called unadjusted, and those with elimination of dominated plants were considered adjusted.

Estimates of BLUP, accuracy (r_{gg}) and coefficient of variation were obtained for each site, including all treatments (progenies and clones used as controls). Additionally, the following correlations were estimated: between the independent variable (X) PS and the dependent variable (Y) BLUP's of the DBH of the progenies, without and with adjustment; between the BLUP's and the arithmetic means of the DBH of the progeny means; and between BLUP's measurements taken at three and six years of age.

All analyses were performed using R Core Team (2022) software.

Results

The mean plant survival was relatively high across the seven sites, above 85% for up to three years and above 72% for up to six years (Table 3). However, the percentage of surviving *Corymbia* progenies varied among the experiments/sites. The means were 69.9% (site 7 - *C. maculata*) and 98.6% (site 6 - *C. torelliana*) at three years and 37.4% (site 5 - *C. maculata*) and 95.1% (site 4 - *C. torelliana*) at six years. Thus, on average, at the seven sites, the percentage of dead plants from planting to three years was 14.86%, and from three to six years, it was 12.78%, i.e., very similar mean results. However, it should be noted that this percentage varied among the assessment settings. For example, at site 2, the loss of plants from planting to three years was only 3.5%, and from three to six years, it was even lower, at 1.4%. At site 7, the mean plant mortality was much greater from planting to three years (30.1%) than from three to six years (5.1%).

Table 3. Estimates of the mean percentage of survival, diameter at breast height (DBH) and lower and upper limits of the estimates obtained in the *C. maculata* and *C. torelliana* progenies evaluation experiments. The data from experiments conducted at seven sites were evaluated at three and six years, considering or not considering the elimination of dominated plants (those with a DBH less than one standard deviation below the mean).

Years	Sites	DBH				% Survival			
		Without		With		Without		With	
3	1	9.8	(6.9-14.7)	11.1	(8.3-14.9)	72.8	(45-100)	58.6	(30-100)
	2	9.3	(7.4-13.8)	9.7	(8.4-13.8)	96.5	(50-100)	84.3	(23-100)
	3	6.9	(5.9-8.8)	7.3	(6.4-9.1)	89.0	(53-98)	78.0	(33-93)
	4	7.6	(0.0-12.1)	7.9	(0.0-12.1)	92.8	(0-100)	76.4	(0-93)
	5	7.9	(5.0-13.4)	8.9	(6.7-13.4)	76.4	(40-100)	61.8	(30-100)
	6	9.1	(5.9-15.4)	9.6	(8.1-15.4)	98.6	(75-100)	85.7	(25-100)
	7	9.9	(7.1-17.7)	10.7	(8.2-17.7)	69.9	(38-100)	59.1	(18-100)
6	1	16.1	(8.2-26.4)	17.9	(11.9-22.9)	44.7	(10-100)	36.8	(0-100)
	2	13.8	(10.0-22.9)	14.4	(11.9-22.9)	95.1	(35-100)	83.9	(22.5-100)
	3	11.9	(9.5-19.3)	12.6	(10.4-20.7)	81.1	(30-100)	70.8	(27-88)
	4	12.2	(0.0-24.9)	12.9	(0.0-24.9)	88.7	(0-100)	75.8	(0-98)
	5	15.3	(9.5-27.3)	17.0	(12.6-27.3)	37.4	(3-98)	30.0	(3-98)
	6	14.1	(8.1-25.4)	15.1	(12.2-25.4)	94.7	(35-100)	80.4	(18-100)
	7	14.3	(9.29-24.2)	16.0	(11.3-24.2)	64.8	(35-98)	52.8	(23-98)

*The identification of the respective sites is shown in Table 1. Without – not considering the occurrence of dominated plants and with – considering the occurrence of dominated plants.

Notably, there was a difference in the mean survival of the progenies, which was observed in the lower and upper limits of survival at each site. At many sites, some progenies showed 100% survival; however, in some cases, all or almost all of the plants of a given progeny died (Table 3); in others, the plants did not die but presented much lower survival than the others (dominated plants); therefore, it is possible that this difference may affect the experimental quality.

Plants that presented an estimated DBH of one or more standard deviations below the mean were also considered dominated. As expected, the overall mean survival decreased, indicating that numerous plants were considered dominated. The difference between the mean survival of plants at three years (85.1%) and that obtained considering the elimination of dominated plants (72.0%) showed that 13.1% of the plants had a DBH one standard deviation below the mean. After three to six years, the percentage of dominated plants was 10.9% (72.4 - 61.5%) (Table 3).

The wide variation in dead or dominated plants between sites is a very favourable condition for achieving the objective of this study, which is to evaluate the consequences of plant losses on the quality of experiments when evaluating progenies of *C. maculata* and *C. torelliana* early during its development or close to the felling of trees.

There was a significant difference in the mean DBHs between the sites. The mean length of the sites ranged from 6.9 cm (site 3) to 9.9 cm (site 7) at three years of age and 11.9 cm (site 3) to 16.1 cm (site 1) at six years of age (Table 3). The difference between the lower and upper limits of the mean DBH among the progenies was high, indicating variation between the means of the progenies at the different sites. As expected, when only plants with DBHs at least one or more standard deviations below the mean were eliminated, a mean increase in DBH occurred. At three years, the increase in the general mean was 7.8%, and at six years, it was 8.4%; that is, the effect of eliminating dominated plants, in terms of the general mean of the progenies, was relatively small (Table 3).

The estimates of the correlations between DBH and survival (r_{ds}), considering the means of the progenies at each site, showed great variation (Table 4). The correlation estimates increased slightly when calculated over six years compared to three years. Considering the three years and involving all sites, the r_{ds} ranged from -0.02 (site 3) to 0.60 (site 7). At six years of age, the lowest r_{ds} was for site 3 (-0.20), and the highest was for site 1 (0.71). Whether dominated plants were considered or not had little effect on the r_{ds} estimates, although in all the cases, there was a tendency for the value to increase when dominated plants were included. Taking the mean of the seven sites as a reference and considering all plants, only 11.6% ($r_{ds} = 0.34^2$) of the DBH variation was explained by survival at three years. This value rose to 13.7% ($r_{ds} = 0.38^2$) in assessments at six years of age.

Table 4. Estimated correlations between the percentage of progenies surviving each experiment and the BLUP estimate of the DBH of each progeny per experiment. For DBH, the correlation between BLUP and the arithmetic mean (r_{mb}) of each progeny per site was also estimated. Correlations between the estimates of BLUPs obtained in the evaluation of progenies of *C. maculata* and *C. torelliana*. The data were obtained from experiments conducted at seven sites on which evaluations were performed at three and six years, considering the elimination of dominated plants (those with a DBH less than one standard deviation below the mean).

Sites	Correlations of DBH means with Survival				Correlation of BLUP's at 3 and 6 years	
	3 years	6 years	3 years	6 years	Without	With
	Without	With	Without	With		
1	0.58	0.64	0.71	0.67	0.88	0.85
2	0.21	0.45	0.13	0.36	0.96	0.96
3	-0.02	0.08	-0.20	0.05	0.87	0.89
4	0.47	0.38	0.33	0.52	0.93	0.95
5	0.28	0.53	0.46	0.50	0.81	0.75
6	0.25	0.39	0.21	0.42	0.96	0.96
7	0.60	0.59	0.53	0.56	0.95	0.94

*The identification of the respective sites is shown in Table 1. Without – not considering the occurrence of dominated plants and with – considering the occurrence of dominated plants.

Even considering the experiments with a single tree plot (STP) and 40 repetitions, the estimates of accuracy ($r_{gg'}$) for DBH were of small to medium magnitude. The highest estimated value of $r_{gg'}$ was 0.81 at three years of age after adjustment (site 6). However, regardless of the site, age of evaluation and consideration or absence of dominated plants, of the 28 $r_{gg'}$ estimates obtained, only nine had a magnitude greater than 0.70. In general, the $r_{gg'}$ estimates slightly increased when considering the evaluation performed at six years compared to three years. The same observation is relevant in the comparisons of $r_{gg'}$ when considering the elimination of dominated plants compared to those without elimination (Table 5). Estimates of $r_{gg'}$ varied among the sites. At three years, the lowest estimate was obtained at sites 3 and 4, and the highest was obtained at site 6.

The correlation estimates for DBH using the BLUPs of each treatment at three and six years were noteworthy. These fluctuations were of great magnitude, and only one estimate was less than 0.81 (Table 4). These correlation estimates are consistent with the results already mentioned, according to which there should be no significant differences in the information obtained from plants aged three or six years.

Table 5. Estimates of the accuracy (r_{gg}) and the mean diameter at breast height (DBH) obtained from the experiments evaluating *C. maculata* and *C. torelliana* progenies. The data from experiments conducted at seven sites were evaluated at three and six years, considering or not considering the elimination of dominated plants (those with a DBH less than one standard deviation below the mean).

Sites		Accuracy		Mean	
		3 years	6 years	3 years	6 years
1	Without	0.52	0.63	9.82	16.07
	With	0.54	0.64	11.07	17.86
2	Without	0.69	0.73	9.34	13.82
	With	0.75	0.77	9.68	14.44
3	Without	0.43	0.56	6.91	11.86
	With	0.51	0.61	7.30	12.60
4	Without	0.43	0.58	7.57	12.22
	With	0.51	0.63	7.92	12.88
5	Without	0.66	0.70	7.93	15.30
	With	0.69	0.69	8.95	17.10
6	Without	0.77	0.73	9.13	14.07
	With	0.81	0.76	9.61	15.08
7	Without	0.69	0.56	9.86	14.33
	With	0.74	0.58	10.66	16.03

*The identification of the respective sites is shown in Table 1. Without – not considering the occurrence of dominated plants and with – considering the occurrence of dominated plants.

The correlation estimates, considering the DBH, between the arithmetic means and the BLUP estimates between the progenies were all great in magnitude, close to 1.0 (Table 6). In other words, the classification of progenies by means was practically the same as that obtained by BLUPs, regardless of age, at all sites. These correlation estimates also allowed us to infer that the inclusion of dominated plants did not affect the analysis results. Additionally, although the experiments presented different levels of imbalance, the variation in survival between progenies and between sites did not affect the estimates of the correlations of the means and BLUPs obtained. In other words, the use of mixed models did not significantly mitigate the variation in PS between experiments.

Table 6. Estimated correlations between the means of the progenies and the estimates of the respective BLUPs for the trait diameter at breast height (DBH) obtained in the evaluation of *C. maculata* and *C. torelliana* progenies. The data from experiments conducted at seven sites were evaluated at three and six years, considering or not considering the elimination of dominated plants (those with a DBH less than two standard deviations below the mean).

Sites	3 years		6 years	
	Without	With	Without	With
1	0.99	0.99	0.99	0.98
2	0.99	0.99	0.99	0.99
3	0.99	0.99	0.99	0.99
4	0.99	0.99	0.99	0.99
5	0.98	0.98	0.94	0.94
6	0.99	0.99	0.99	0.99
7	0.99	0.99	0.99	0.99

*The identification of the respective sites is shown in Table 1. Without – not considering the occurrence of dominated plants and with – considering the occurrence of dominated plants.

Discussion

The experiments were carried out at seven sites in three States with different edaphoclimatic conditions that well represent the cultivation conditions of planted forests in Brazil (Table 1). This strategic choice is based on the relevance of these States, which play a significant role in the national production of planted forests. As mentioned previously, non-*Corymbia* controls (clones) were included in all the experiments. Furthermore, the progenies were not common at all sites; four sites included the progeny of *C. torelliana,* and three sites included the progeny of *C. maculata*. Even so, as survival was assessed by site, term progenies were considered in the discussion, regardless of whether they were progenies of the same species or whether they were clones, without the concern of being the same from one site to another. This is because, in the context of the research objectives, the interest is to determine the implications of the difference in survival based on the "quality" of the information obtained.

Although the first introductions of *C. maculata* and *C. torelliana* plants in Brazil occurred more than fifty years ago, these plants have only recently received increased amounts of attention from breeding programs, mainly because they are highly tolerant of certain climatic stresses (Reis et al., 2014a; Reis et al., 2014b; Silva et al., 2017; Araújo et al., 2021; Silva et al., 2022). Additionally, it seems that these species are tolerant to disturbances that cause extensive damage to clones from species of the genus *Eucalyptus* in some regions of southern Bahia and Espírito Santo, Brazil. For this reason, obtaining information that can improve progeny evaluations is essential.

The mean percentage plant survival (PS) of the progenies was 85.1% at three years and 72.4% at six years. However, there was a wide variation in PS between and within sites. For example, the prevalence of PS at age 6 years ranged from 37.4% (site 5) to 95.1% (site 2) (Table 3).

There was also wide variation in PS among progenies. Considering again the PS evaluation performed at six years of age, progenies with 100% survival were identified at two sites, and the lower limit of PS was lower than 36%. In an evaluation of the PS of the species of the genus *Corymbia* in Itatinga, state of São Paulo, the PS of *C. maculata* progenies was 93% (Silva et al., 2022) and that of *C. torelliana* was 95% (Araújo et al., 2021). These results allow us to infer that the adaptation of *Corymbia* in Brazil is relatively good, although this species is still considered at the beginning of domestication in Brazil (Reis et al., 2014a; Reis et al., 2014b).

Survival is a quantitative trait whose phenotypic variation must include genetic, environmental, and genotype-by-environment (GE) interactions. The genetic variation was confirmed by the difference between the PSs of the progenies. The existence and interaction of progenies according to environment/site could not be estimated because at each site, the plot consisted of only one plant, i.e., there was no repetition of PS per site. The existence of variation in the mean PS between the sites can be considered environmental, provided that 40 plants are considered a representative sample of each progeny. The differences in environmental conditions between the different sites can be attributed to other factors, including climatic conditions, nursery seedling management, especially at planting, and the occurrence of pests and diseases.

Regardless of the origin of the variation in plant survival in these experiments, it was fundamental for the objectives of this study to be achieved. That is, verification of the possible effects of variations in survival on the quality of the experiments was necessary. Considering that each plot had only one tree (STP), the difference in survival causes an imbalance in the number of repetitions of the treatments, and consequently, a reduction in the accuracy of the selection of the progenies is expected. Unfortunately, no reports on this topic were found in previous studies in the literature evaluating progenies of any other species of the genus *Corymbia.* There are reports in this regard for evaluation experiments of progenies of the genus *Eucalyptus*, especially with plots containing several plants (Araujo et al., 2015) and in STP (Ferreira et al., 2020).

The first question is what are the implications of the difference in survival in terms of the plants that remained in the experiment? One of the implications is that some researchers question the use of STPs because a given plant of a progeny could benefit from the lack of survival of one or more neighbouring plant(s). In fact, with a reasonable number of progenies being evaluated with 40 repetitions, which were randomly distributed, as in the present study, the probability that any progeny would benefit is very small. This finding was also confirmed by Santos et al. (2021) in experiments involving the evaluation of eucalyptus clones at various sites. As each progeny was tested 40 times, the mean performance of any of the progenies was not significantly improved. This can be confirmed by estimating the correlation (r_{ds}) between PS as the independent variable and the mean growth and development of the progenies using the mean DBH as the reference variable. Three situations could occur: estimates of positive and high r_{ds}, that is, the DBH would increase with increasing PS; negative and high or r_{ds}, i.e., the highest DBH means, would occur when the PS was of lower magnitude and the third option or r_{ds} close to zero, i.e., the DBH mean, and the PS would be independent. The estimates of r_{ds} obtained in this study were, in general, of small magnitude, although many had r_{ds} different from zero (Table 4). It appears that only a small proportion of the differences in DBH were explained by variations in PS; that is, the magnitude of DBH was independent of PS, as was also observed by Costa et al. (2009).

When there was a difference in survival, the experiments were unbalanced, especially in the case of the one tree plot (STP) experiment, because plant losses led to a loss of repetitions. In this situation, the best option is to perform the analyses using mixed models (MM) (Resende, 2015; Bernardo, 2020). One of the ways to evaluate the efficiency of the use of MM, to the detriment of the method of least squares, that is, the arithmetic mean of the data of each progeny, is through the estimates of the correlation between the means of the DBH in the present study and the estimates of the BLUPs of the referred treatments. In the present case, the estimates of correlations between the means of the progenies and the estimates of the respective

BLUPs (r_{mb}) for the situations with and without adjustment of the dominated plants at three and six years were all high, that is, above 0.93 (Table 6). It appears that, despite the unbalanced experiments, the magnitude of the imbalances (difference in the percentage of survival) was insufficient to significantly affect the classification of the progenies (Reis et al., 2011).

Another way of evaluating the difference in the number of plants/repetitions per progeny in terms of the quality of the information obtained is through estimates of the accuracy. Initially, the experiments were performed in the STP with 40 repetitions. Even so, the estimates of $r_{gg'}$, although different between sites and considering or not considering the dominated plants, were of low to medium magnitude. The $r_{gg'}$ ranged from 0.43 to 0.77 (Table 5). At six years of age, there was a slight increase, although the same trend was observed for the differences in PS. Notably, when plants with a DBH less than one standard deviation below the mean per site were eliminated, there was a small increase in the estimates of the accuracy.

From the above, it can be inferred that the precision of the evaluated experiments, based on the accuracy estimates, is practically independent of the percentage of survival and level of imbalance. Unfortunately, as previously mentioned, no information in this regard was found in the literature for species of the *Corymbia* genus. However, in an experiment evaluating progenies, especially clones of the genus *Eucalyptus*, the results were consistent with those found in the present study (Ferreira et al., 2020; Santos et al., 2021). It should be noted, however, that the estimates of accuracy in these *Corymbia* genus experiments were of lower magnitude than those obtained under other conditions involving the evaluation and progenies or mainly clones of the genus *Eucalyptus*. The lower accuracies of the *Corymbia* genus can be attributed to several factors, such as the lower adaptation of the species than that of *Eucalyptus grandis* and *Eucalyptus urophylla*. Another perhaps more important factor is the variation among plants of the same progeny. In the literature, there are reports that the genetic variation within progenies is greater than that among progenies (Silva et al., 2022). Thus, in the STP experiments, the genetic variation within the progenies, together with the environmental variation that normally occurs, is partly controlled by the source of the block variation. However, when there is much variation between blocks, in the case of plants between progenies, this variation contributes to a greater estimate of the progenies x blocks interaction that is included in the error. Thus, part of the error magnitude is a function of the genetic variance within the progenies that contributes to the increase in error variance and, consequently, decreases the accuracy estimate.

However, Resende and Alves (2022) argue that the magnitude of the accuracy depends on the stage of the breeding program. For example, in the final evaluation of clones for recommendation for forest exploitation, the $r_{gg'}$ must have a magnitude above 0.93. However, in a situation such as the one in the present study involving early stages of progeny evaluation of species in the domestication phase, $r_{gg'}$ values less than 0.5 are acceptable. According to the results in Table 5, even considering the difference in survival, the experiments should not be discarded in any of the situations due to the estimates of accuracies obtained.

Finally, it is worth noting that the studies conducted to date with the objective of verifying the effect of the difference in plants/repetitions in the experiments were conducted with data collected over three years. In this situation, it has been questioned whether three years would be enough time to generalize the data. In the present study, this information was obtained at three and six years of age, and the results were quite similar. This information is very useful to breeders of this genus, because, in principle, practically the same genes that affect the DBH of plants at three years of age, which are not few, are also expressed at six years of age. This will occur if the correlation of DBH estimates at the two ages is high.

To confirm this result, the correlations of the BLUPs of the progenies at three and six years were estimated, considering, or not considering the dominated plants, and as can be observed in Table 4, only six estimates were less than 0.94. These estimates confirm what has been previously mentioned: the difference in survival at three or six years does not significantly affect the classification of progenies. This information corroborates that the use of early selection is efficient. Several studies have been conducted on this topic in relation to species of the *Eucalyptus* genus (Rezende et al., 1994). However, no information was found on the efficiency of early selection in the genus *Corymbia*.

Conclusion

The survival rates of *Corymbia maculata* and *Corymbia torelliana* plants differed among progenies, ages, and evaluation locations. In other words, there are variations in genetic and environmental effects, implying that in the medium term, it would be possible to select progeny for greater survival, but this process is still dependent on environmental conditions. Estimates of accuracy were not significantly affected by differences in survival and/or the occurrence of dominated plants. Experimental precision was not significantly influenced by the difference in plant survival and percentage of dominated plants. The correlation estimates involving DBH at ages three and six were all large. Thus, early selection carried out at age three is viable in experiments with these species regardless of survival and environmental conditions.

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