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Seed sowing time effect on germination and growth of rubber seedlings

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ABSTRACT: Rubber seeds are recalcitrant seeds and cannot withstand intensive desiccation. The time from seed falling off rubber tree to seed sowing is crucial for germination and seedling growth. The present study compared the sowing time effect of GT1 and Reyan73397 seeds after harvest on germination and seedling growth. The results showed that GT1 seeds after harvest should be sown during 3 days and Reyan 73397 seeds should be sown during one day, seed germination was negatively correlated with seed width and seed weight, seedling plant height and leaf SPAD value was negatively correlated with seed length. Taken together, seed sowing time affects seed germination and the growth of rubber seedlings, and understanding seed sowing time effects helps to collect and transport seeds timely so as to sow and obtain high-quality rootstock seedlings.

KEYWORDS: Rubber seeds, seed sowing time, germination, seedling growth.

1 INTRODUCTION

Rubber seeds are recalcitrant seeds and sensitive to desiccation [1,2]. When rubber seeds are ripe and fall off rubber trees, seed vigor loss with seed moisture content decline during seed collection [3], transportation and storage [4]. The loss of rubber seed vigor damage germination and rootstock seedling quality. Several literatures have reported rubber seed vigor and germination loss in superoxide dismutase [5], leachate conductance [6,7], respiration electron transport pathway [8], and temperature [9-11]. However, there is lack of research on seed sowing time affecting germination and seedling growth after seed collection. Hence, the present study aims to evaluate effect of seed sowing time on germination and seedling growth, to identify suitable sowing seed time for rubber propagation.

2 MATERIALS AND METHODS

The experiment was conducted from November 2020 to January 2022 at the nursery base of natural rubber of Rubber Research Institute of Chinese Academy of Tropical Agricultural Sciences, Danzhou City, Hainan Province, China. Seeds are dropped on the same day, collected on the same day, and then sown in separate days. During the seed drop period, the average maximum temperature was 24.03℃, the average minimum temperature was 17℃, and the average rainfall was 0.72mm. When seeds were mature and fell off rubber trees (19.50N, 109.49E), seeds of clone GT1 and Reyan 73397 (Fig.1) were immediately harvested and sown in drip irrigation seedling tray (36cm width*53cm length, each hole size 6cm upper diameter *2.5cm lower diameter *12cm height) with coconut bran for 5 consecutive days, respectively. Seeds shape (length, width and height) and stem diameter of seedlings were measured with vernier caliper (0.01 mm). Leaf size (length and width) and plant height of seedlings were recorded with plastic/steel ruler (0.1 mm). A Portable Chlorophyll Meter (CY-YL04, China) was used for detecting chlorophyll content (SPAD value) and nitrogen content during 9: 30-10: 30. Statistical analyses were performed with data processing system (DPS) statistical software package version 16.5 using student's *t-test* to evaluate significant difference between seedlings of GT1 and Reyan 73397 clones at $P<0.05$. All data were shown in the mean ± SE. Correlation heatmap analysis was performed on Tutools platform (http://www.cloudtutu.com), a free online data analysis website.

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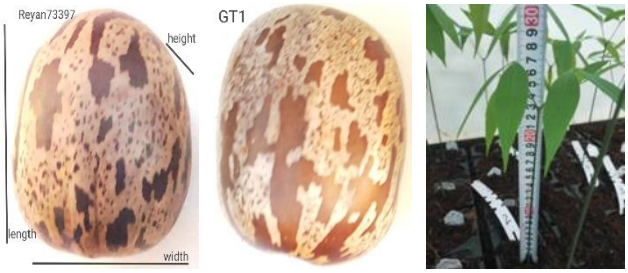

Fig. 1. Seeds and seedlings at mature leaf stage

3 RESULTS AND DISCUSSION

3.1 SEED SHAPE CHARACTERISTICS

As shown in Figure1 and Figure 2A-C, clone Reyan73397 were more 5.96% ($P < 0.0001$) in seed length and 10.62% ($P < 0.0001$) in seed width than clone GT1, respectively. There was no significant difference in seed height between Reyan73397 and GT1. The parents of clone Reyan73397 is RRIM600 and PR107, while GT1 is a primary clone. These results suggest that GT1 and Reyan 73397 clones have significant different seed shape and size.

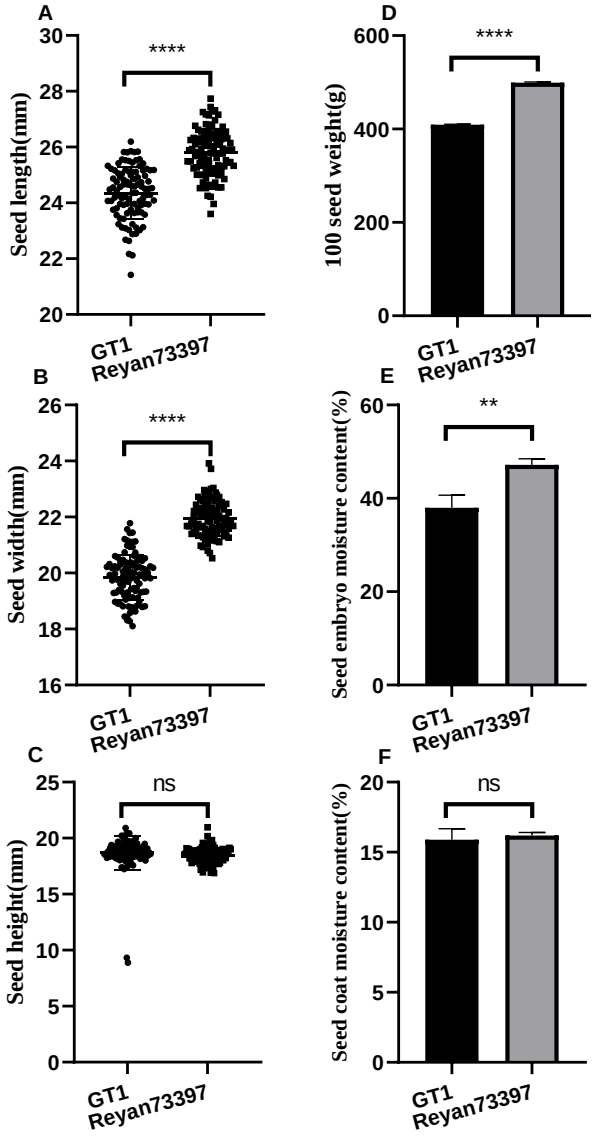

Fig. 2. Seed shape characteristics (A-C), 100 seed weight (D) and moisture content (E-F) when dropped from rubber tree

3.2 SEED WEIGHT PER 100 AND MOISTURE CONTENT

As shown in Figure 2D-F, clone Reyan73397 were more 22.08% ($P < 0.0001$) in 100 seed weight and 24.25% ($P < 0.01$) in seed embryo moisture content than clone GT1, respectively. There was no significant difference in seed coat moisture content between Reyan73397 and GT1. These results suggest that seed coat of GT1 and Reyan 73397 clones have no significant moisture content when falling off rubber trees.

3.3 SEED GERMINATION

As shown in Figure3A, seed germination decreased gradually with the extension of sowing time. GT1 seeds germination sown on the first day after harvest was 74.19%, germination sown on the second day was 8.40% lower than that sown on the first day, germination sown on the third day was 6.33% lower than that sown on the second day, and the ones sown on the fourth day was 16.22% lower than that of the sowing on the third day, and germination of the sowing on the fifth day was 9.91% lower than that of the sowing on the fourth day. The initial germination rate of GT1 seeds was 36.69% higher than that of Reyan 73397. Reyan 73397 seeds germination sown on the first day after harvest was 37.50%, germination sown on the second day was 4.17% lower than that sown on the first day, the seed germination sown on the third day was 4.38% lower than that sown on the second day, and germination of the seeds sown on the fourth day was 1.92% lower than that of sowing on the third day, and germination of the sowing on the fifth day was 19.13% lower than that of sowing on the fourth day. These results suggest that rubber seeds after harvest should be sown during 3 days. The germination rate of fresh GT1 seeds is not the highest, after the seeds are dehydrated for a short time, seed moisture content decrease to a certain extent, and seed germination increase [1,2], which are inconsistent with ours and may be related to the initial state of the seeds and the different geographical environment. Junaidi and Mochlisin imply that the direct sowing after dehiscent is the best way to attain a high germination rate [3]. The above result support the conclusion that the time from seed dehiscent to sowing influence the germination rate.

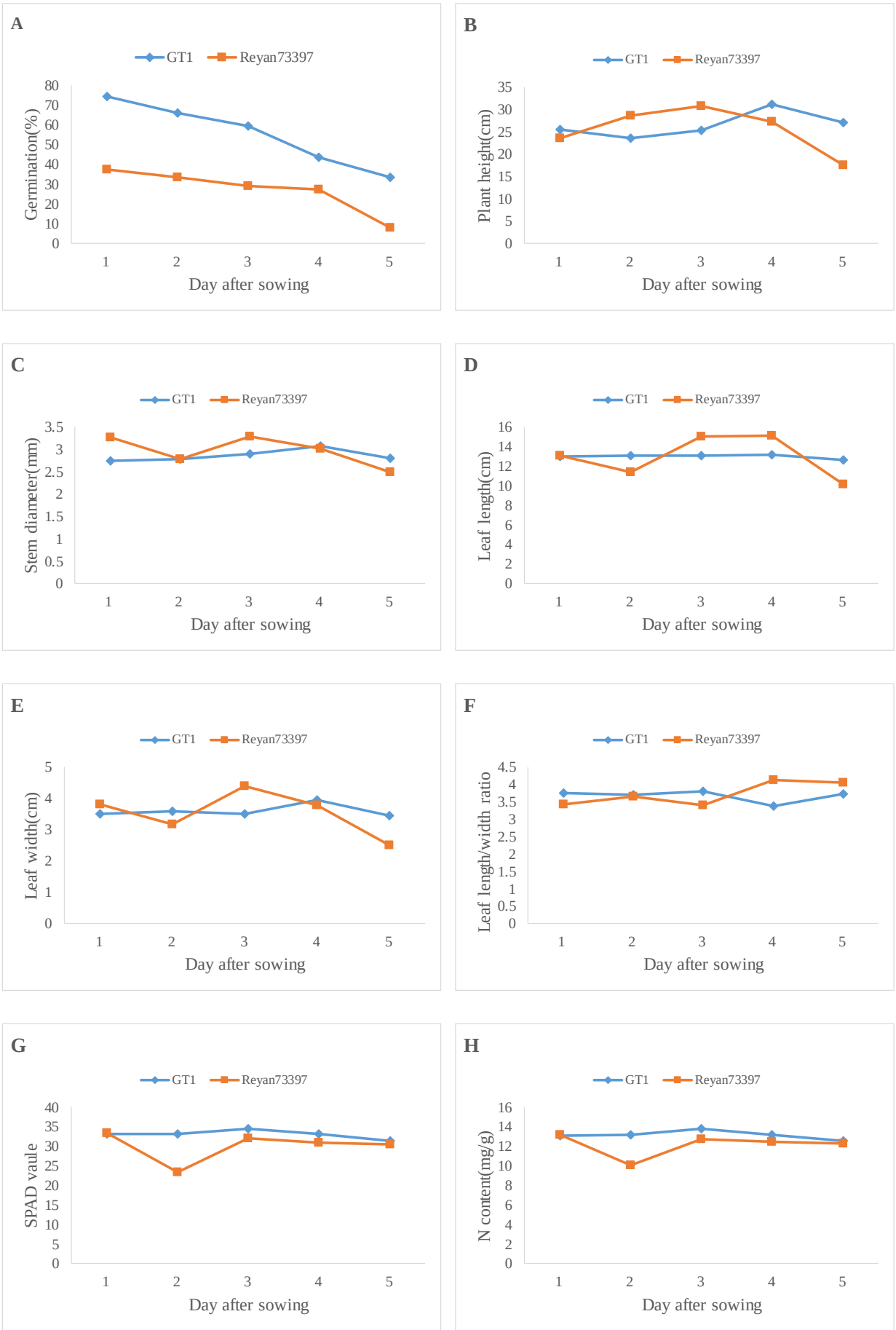

Fig. 3. Seed germination (A) and seedling growth parameters (B-H) at different days after sowing

3.4 SEEDLING GROWTH PARAMETERS

As shown in Figure3B-H, plant heights of GT1 and Reyan 73397 seedlings showed opposite trends in the first 3 days after sowing. GT1 seedlings had the highest plant height (31.09 cm) on the 4th day after harvest, while Reyan 73397 seedlings had the highest plant height (30.75 cm) on the 3rd day after seed harvesting. Stem diameter of GT1 seedlings showed an increasing trend in the first 4 days after seed sowing, and reached the maximum (3.08mm) when sowing on the 4th day after seed harvesting. However, the stem diameter of Reyan 73397 seedlings did not change regularly with the sowing time, and the stem diameter reached the maximum (3.28mm) when sowing the seeds on the 3rd day after the seeds were harvested. The maximum leaf length of GT1 and Reyan 73397 seedlings both reached the maximum sowing on the 4th day after seed harvesting. Leaf length varies irregularly with sowing time. The maximum leaf width of GT1 and Reyan 73397 seedlings reached the maximum when sowing on the 3rd and 4th day after seed harvesting, respectively. The leaf length width ratio of GT1 and Reyan 73397 seedlings reached the maximum on the 3rd and 4th day after seed harvesting, respectively, and the leaf length width ratio of GT1 and Reyan 73397 seedlings did not change regularly with sowing time. The N content and SPAD value of GT1 and Reyan 73397 seedlings consistently reached the maximum on the 3rd and 1st day after seed harvesting, respectively. The N content and SPAD value of GT1 seedlings varied little with sowing time, while that of Reyan 73397 seedlings showed a decreasing trend with the sowing time except the second day of sowing. These results suggest that GT1 seeds after harvest should be sown during 3 days and Reyan 73397 seeds after harvest should be sown during 1 day.

3.5 CORRELATION ANALYSIS

As shown in Figure4, there was a significantly positive correlation between leaf SPAD value and germination (r=0. 86, p<0.05), between leaf width and stem diameter (r=0.82, p<0.05), between seed embryo moisture content and 100 seed weight (r=0.88 p<0.05), between seed width and 100 seed weight (r=0.87, p<0.05), respectively. There was a significantly negative correlation between leaf width and germination (r=-0. 97, p<0.01), between 100 seed weight and germination (r=-0.96, p<0.01), between plant height and seed length (r=-0.82, p<0.05), between leaf SPAD value and 100 seed weight (r=-0.90, p<0.05), between leaf SPAD value and seed length (r=-0.84, p<0.05), respectively. These results indicate that seed shape and weight influence seedlings growth after seed sowing

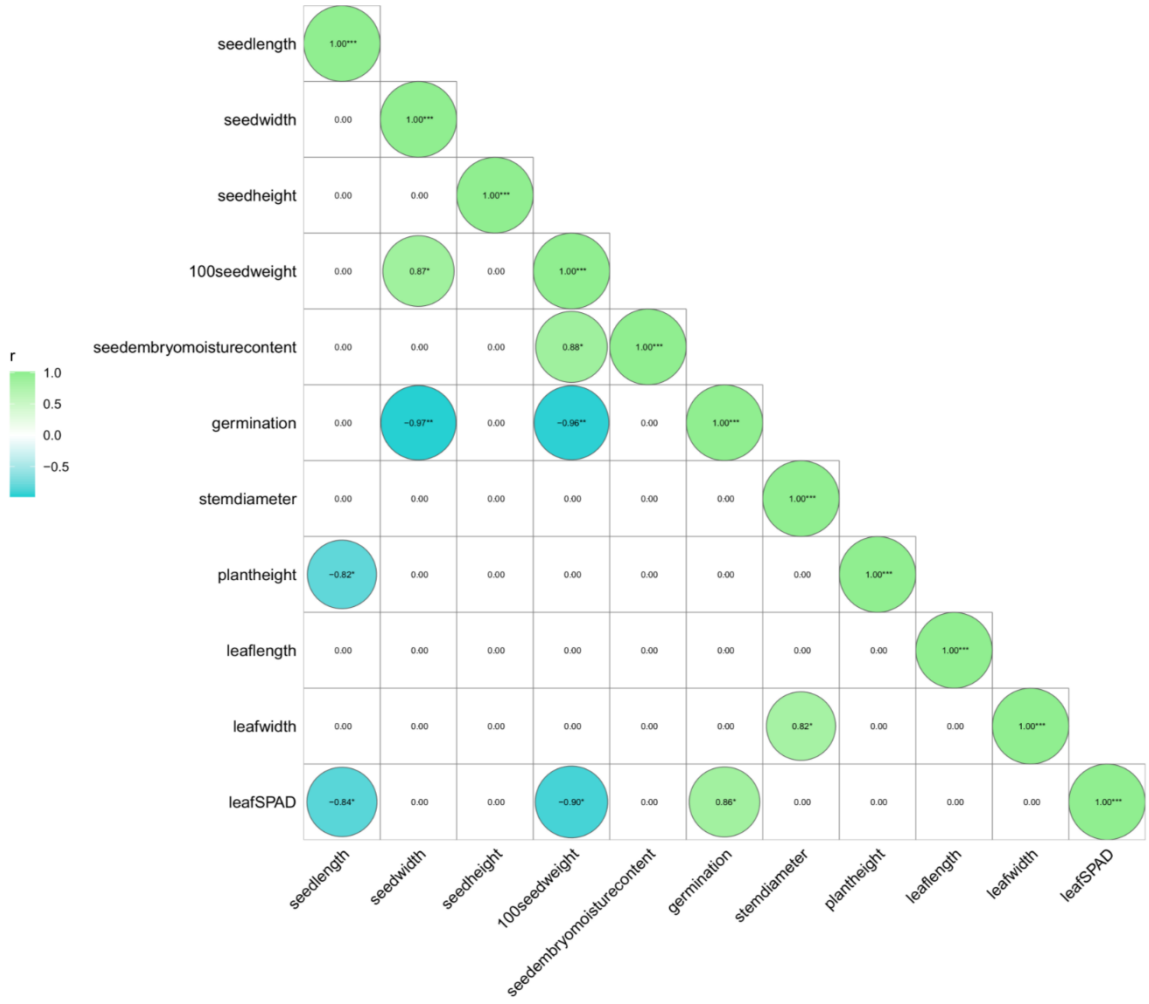

Fig. 4. Correlation analysis among seed shape characteristics, seed germination and seedling growth parameters

4 CONCLUSION

Rubber seed sowing time after harvest significantly affected germination and seedling growth. GT1 seeds after harvest should be sown during 3 days and Reyan 73397 seeds after harvest should be sown during 1 day. Rubber seed shape and weight influence seedlings growth after seed sowing. Rubber seed germination was negatively correlated with seed width and 100 seed weight, respectively. Rubber seed length was negatively correlated with seedling plant height and seedling leaf SPAD value.

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AUTHORS' CONTRIBUTION

X.H. Chen conceived the experiments, R.X. Wang and X.H. Chen conducted the experiments, R.X. Wang and X.H. Chen analyzed the data and drafted the manuscript, R.X. Wang, X.H. Chen, and J. Wang discussed the results and finalized the manuscript.

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