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Root cutting retards scion sprouting and subsequent growth of rubber buddings

Ruxue Wang[1,2], Xianhong Chen[1*], Jun Wang[1]

[1]Rubber Research Institute，Chinese Academy of Tropical Agricultural Sciences，Danzhou，Hainan，China
[2]Yunnan Agricultural University，Kunming, Yunnan, China
*Correspondence author. E-mail address: chenxhongjane@163.com (X. Chen).

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***Abstract*— *Rubber ground nursery is one of rubber seedling propagation. However, there is still a lack of systematic studies investigating root cutting effect on rubber budding nursery. In this study, sprouting rate, scion stem diameter and plant height, and root stock diameter were observed between non-in situ and in situ buddings over five periods. The results showed that root cutting destroyed rootstock, retarded rubber scion sprouting rate and influenced subsequent growth such as plant height, scion diameter, leaf width and leaf length-width ratio.*

***Keywords*— *root cutting, sprouting rate, growth, rubber buddings*.**

I. INTRODUCTION

Rubber grafting seedling production in China mainly use plastic bags to raise seedlings and nursery for 15 months at least, which usually causes seedling roots twisted and avoid root- twisted to cut the roots out of plastic bag. However, there is still a lack of systematic studies investigating root cutting effect on rubber budding nursery. Several studies have documented root-cutting retarded the seedling growth[1-5], affected hormones, mineral nutrition, carbohydrate, water and brought senescence characteristics in the seedlings[6-8]。Overall, these studies highlight the disadvantage of root cutting in different species seedlings. Here we investigated the growth process of budded stump and polybag budding from digging out of the ground to transplant out of the nursery in order to further extend current knowledge of rubber budding propagation.

II. MATERIAL AND METHODS

The experiment was conducted from November 2019 to October 2021 at the nursery base of natural rubber of Rubber Research Institute of Chinese Academy of Tropical Agricultural Sciences, Danzhou City, Hainan Province, China. Clone GT1 seeds were sown in sand bed for germination and about 20-25 days later the GT1 seedlings as rootstock were transplanted in ground nursery for budded stump nursery and polybags(15cm width*38cm length) for seedling nursery, respectively. The budded scion was clone CATAS 7-33-97. After budding successfully, budded stump was dug out of the ground with root cutting and raised in polybags with surface soil(Fig.1), and the method of budded stump nursery was marked as non in situ budding. Meanwhile, budded seedlings was moved out of seedling nursery with root mass and raised further to sprout with one leaf whorl(Fig.1), and the method of budded seedling nursery was marked as in situ budding. At scion elongation stage and scion leaf stable stage of non in situ and in situ buddings, germination rate, diameter and plant height were recorded, and correlation analysis among rootstock/scion diameter and scion plant height was evaluated, respectively. Vernier caliper (0.01 mm) and plastic ruler (0.1 mm) was used to measure stem diameter, plant height, leaf length and width respectively. At different phenological phase leaf length, leaf width and ratio of leaf length and leaf width was measured. Statistical analyses were performed with data processing system (DPS) statistical software package version 16.5 using student t-test and one-way ANOVA followed by the Duncan's Multiple Range Test (SSR) to evaluate significant difference between non in situ and in situ buddings and among different phenological phase, respectively. Correlation heatmap analysis was performed on Tutools platform(http://www.cloudtutu.com), a free online data analysis website.

Fig. 1 The representative view of growth and development of rubber buddings in polybags nursery.

III. RESULTS AND DISCUSSION

3.1 Root cutting decreases sprouting rate As shown in Figure2A, sprouting rate of non-in situ was 73.84%(p<0.0001) less at elongating stage and 67.74%(p<0.0001) less at stable leaf stage, than those of in-situ, respectively. As predicted, our investigation show that root cutting influenced sprouting rate, which was consistent with seedling-raising effects in *Cornus silsoniana*[9] and *Parashorea chinensis*[10].

3.2 Root cutting retards the growth in scion stem diameter, plant height and leaf development As shown in Figure2B, scion stem diameter of non-in situ was 20.15%(p<0.0001) less at elongating stage, 17.37%(p<0.0001) less at leaf stable stage, than those of in-situ, respectively. Plant height of non-in situ was 24.15%(p<0.0001) less at elongating stage, 8.10%(p=0.0032) less at leaf stable stage than those of in-situ(Figure 2C), respectively. Leaf length of non-in situ at 5 leaf developmental stages demonstrated the same rising trend in comparison with that of in-situ and there were no significant difference in leaf length between non in-situ and in-situ at 5 leaf developmental stages (Figure 2D). Leaf width of non-in situ at 5 leaf developmental stages demonstrated the same rising trend in comparison with that of in-situ. Leaf width of non-in situ increased 2.46cm(94.62%) and leaf width of in-situ increased 1.83cm((87.98%)) from Elongating stage to leaf stable stage(Figure 2E), respectively. Leaf length and leaf width grew faster from bronze stage to light green leaf stage and after that the growth became slower. And leaf length and width of non-in suit grow faster than those of in-suit showing that leaf length and width of non-in situ were larger than those of in situ, except leaf length of bronze stage (Figure 2D,E). Surprisingly, leaf length-width ratio of non-in situ at 5 leaf developmental stages demonstrated the same decreasing trend in comparison with those of in-situ, and significant differences ($p<0.0001$)were observed from elongating stage to bronze stage(Figure 2F), respectively.

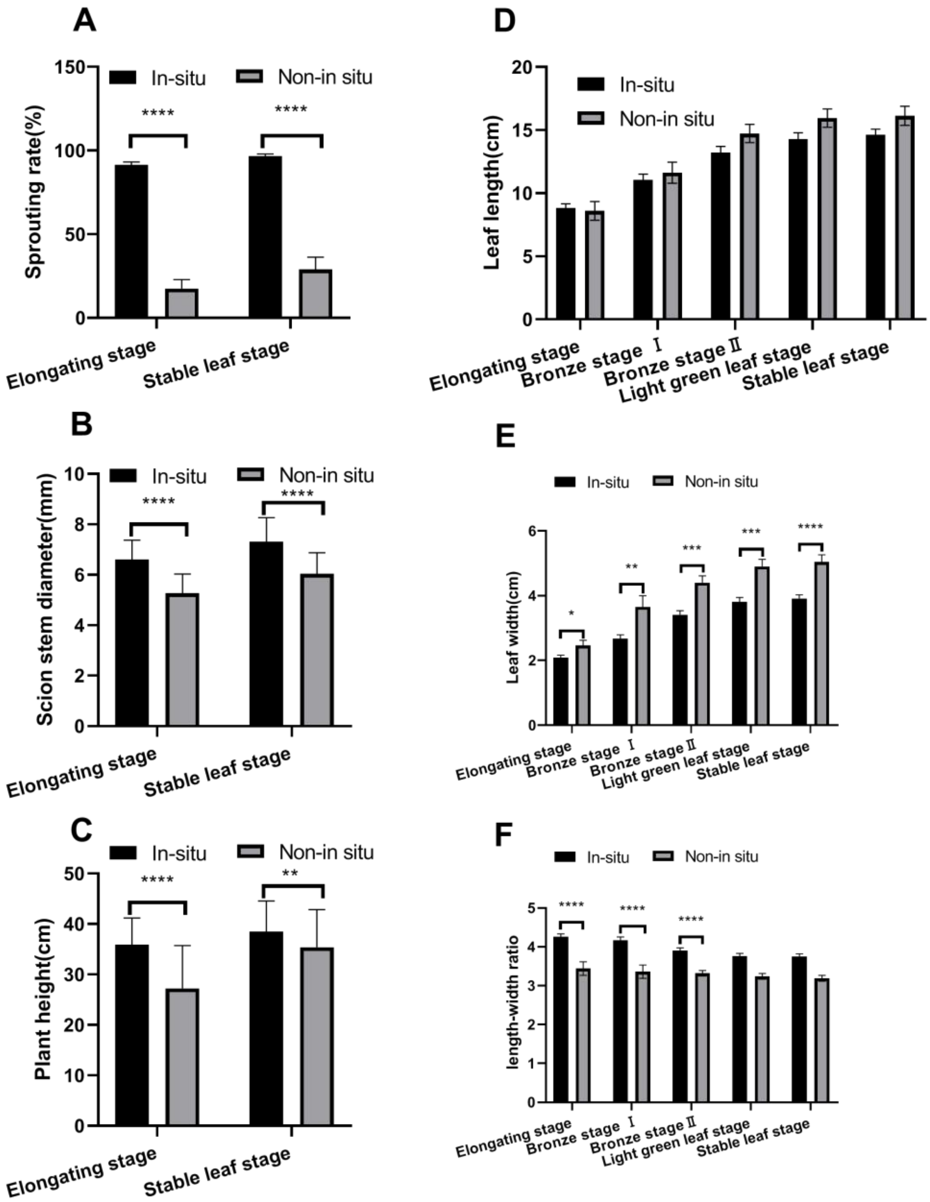

*Fig. 2 Comparison on sprouting(A), scion stem diameter(B), plant height(C)between in-situ and non-in situ rubber buddings. Note: Data are means and SD, n=3, each replication contain 20-30 plants. *, **, ***,****indicate a significant difference at 0.05, 0.01, 0.001 and 0.0001levels, respectively.*

These results suggested in situ buddings had better balanced growth than non-in situ. Taproot-cutting significantly decreased the plant height and basal diameter in *Cunninghamia lanceolata Hook*[3], *Parashorea chinensis*[10], and *Pinus massoniana* seedings[2]. However, compared with the conventional stock grafting without root cutting, double root-cutting grafting significantly increased tomato plant height and stem diameter in late growth stage(fruiting period and picking period) and significantly increased the yield[11], which might be due to species difference.

3.3 Correlation analysis among sprouting rate, rootstock diameter, scion stem diameter, plant height, leaf length, leaf width and leaf length-width ratio As shown in Figure3, for in situ, sprouting rate was positive correlation with scion diameter(elongation stage, r=0.23, p<0.05, and stable leaf stage, r=0.23, p<0.05). Rootstock diameter was positive correlation with scion diameter(elongation stage, r=0.48, p<0.001, and stable leaf stage, r=0.55, p<0.001) and negative correlation with plant height (elongation stage, r=0.26, p<0.01). Scion diameter at elongation stage was positive correlation with scion diameter at stable leaf stage(r=0.89, p<0.001), and with plant height at stable leaf stage(r=0.23, p<0.05). Scion diameter at stable stage was positive correlation with plant height at stable leaf stage(r=0.21, p<0.05). Plant height at elongation stage was positive correlation with plant height at stable leaf stage (r=0.94, p<0.001). There was a positive correlation among leaf length, leaf width and leaf length-width ratio(r>=0.94, p<0.001).

While for non-in situ, sprouting rate was positive correlation with leaf length(bronze stageI, r=0.24, p<0.05 and bronze stageII, r=0.21, p<0.05), and with leaf length-width ratio(bronze stage I, r=0.28, p<0.01, bronze stageII, r=0.24, p<0.05, light green leaf stage, r=0.21, p<0.05, stable leaf stage, r=0.21, p<0.05), respectively. Rootstock diameter was positive correlation with scion diameter(elongation stage, r=0.27, p<0.05, and stable leaf stage, r=0.40, p<0.001). Scion diameter at elongation stage was positive correlation with scion diameter at stable leaf stage (r=0.59, p<0.001), with plant height (elongation stage, r=0.54, p<0.001, and stable leaf stage, r=0.45, p<0.001), with leaf length(bronze stage I, r=0.31, p<0.01, bronze stageII, r=0.39, p<0.001, light green leaf stage, r=0.38, p<0.001, stable leaf stage, r=0.38, p<0.001), with leaf width(bronze stage I, r=0.38, p<0.001, bronze stageII, r=0.38, p<0.001, light green leaf stage, r=0.39, p<0.001, stable leaf stage, r=0.39, p<0.001), and leaf length-width ratio(bronze stageI, r=0.27, p<0.05, bronze stageII, r=0.33, p<0.01, light green leaf stage, r=0.34, p<0.01, stable leaf stage, r=0.33, p<0.01), respectively.

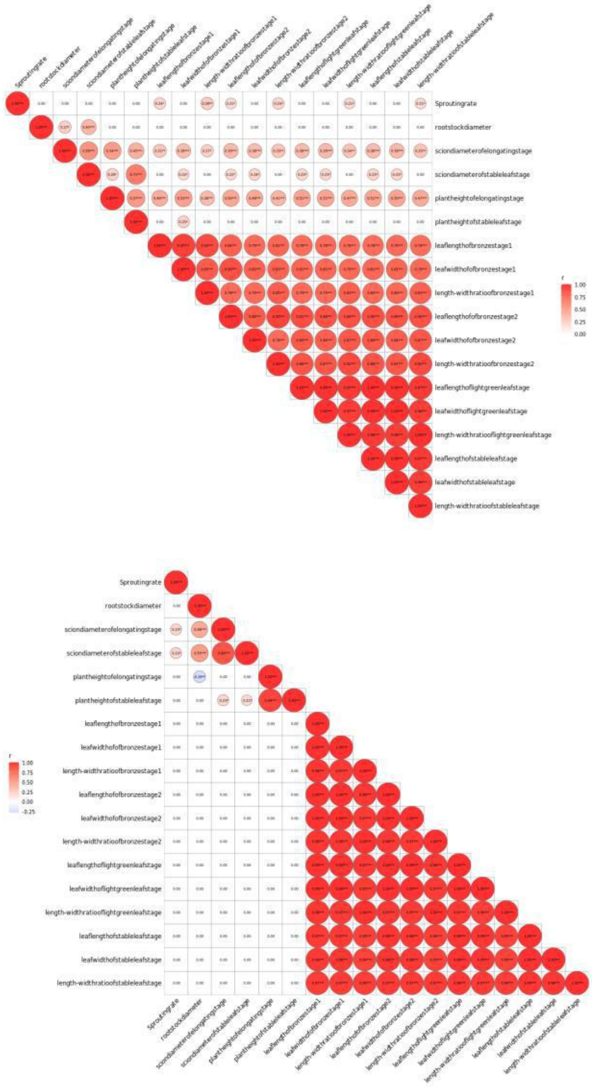

Fig.3 Correlation analysis among sprouting rate, rootstock diameter, scion stem diameter, plant height, leaf length, leaf width and leaf length-width ratio (up, non in situ. down, in situ).

Scion diameter at stable stage was positive correlation with plant height (elongation stage, r=0.26, p<0.05, and stable leaf stage, r=0.71, p<0.001), with leaf length(bronze stageII, r=0.22, p<0.05, light green leaf stage, r=0.23, p<0.05, stable leaf stage, r=0.23, p<0.05), with leaf width(bronze stageI, r=0.22, p<0.05, bronze stageII, r=0.24, p<0.05, light green leaf stage, r=0.23, p<0.05, stable leaf stage, r=0.23, p<0.05), respectively. Plant height at elongation stage was positive correlation with plant height at stable leaf stage (r=0.57, p<0.001), with leaf length(bronze stage I, r=0.46, p<0.001, bronze stageII, r=0.50, p<0.001, light green leaf stage, r=0.51, p<0.001, stable leaf stage, r=0.51, p<0.001), with leaf width(bronze stageI, r=0.53, p<0.001, bronze stageII, r=0.48, p<0.001, light green leaf stage, r=0.51, p<0.001, stable leaf stage, r=0.50, p<0.001), and leaf length-width ratio(bronze stageI, r=0.38, p<0.001, bronze stageII, r=0.41, p<0.001, light green leaf stage, r=0.47, p<0.001, stable leaf stage, r=0.47, p<0.001), respectively. Plant height at stable stage was positive correlation with with leaf width at bronze stageI(r=0.25, p<0.05), respectively. There was a positive correlation among leaf length, leaf width and leaf length-width ratio(r>=0.78, p<0.001).

The above results suggested that sprouting rate was not direct correlation with rootstock, but rootstock influenced significantly scion. Moreover, root cutting for non-in situ affected plant height and plant height affected leaf length, leaf width and leaf length-width ratio.

IV. CONCLUSION

Root cutting destroyed the tap root of rootstock, retarded rubber buddings sprouting and influenced subsequent growth such as plant height, scion diameter, leaf width and leaf length-width ratio.

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AUTHORS' CONTRIBUTION

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

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