Scale Breeding and Reproduction Technique of *Ficus tikoua* Bur. Container Seedlings

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Abstract Based on the principle of asexual reproduction, a kind of scale breeding and reproduction technique of *Ficus tikoua* Bur. container seedlings was explored by using the characteristics of strong adaptability to the environment and fast growth and reproduction. Using non-woven bag as a breeding container for seedlings, the scale breeding and reproduction technique of *F. tikoua* container seedlings was summarized through the important links of seedling bed construction, seedling collection, soil configuration, container selection, cutting cultivation, field management, and disease and pest control. This technique can achieve differential, massive and sustainable efficient breeding and reproduction of *F. tikoua* seedlings in a short time.

Key words *Ficus tikoua* Bur.; Pharmaceutical/food resource; Asexual reproduction; Container seedling; Scale breeding and reproduction

1 Introduction

Ficus tikoua Bur., a perennial evergreen woody creeping vine belonging to *Ficus*, Moraceae, is habitually native to various habitats such as grassy slope, sandy land, river beach, rock wall or rock crevices[1-2]. *F. tikoua* has a wide range of growth, and is found in Hunan, Guizhou, Guangxi, Yunnan, Sichuan and other provinces in China, as well as partial areas of India, Vietnam, Thailand, Laos and other countries[3-4]. The whole plant of *F. tikoua* can be used medically, with the effect of treating diarrhea, jaundice, spermatorrhea, cough, edema, amenorrhea and clearing heat and dampness[5-6]. After ripening, *F. tikoua* fruit is delicious, mellow and nutritious, becoming a wild fruit suitable for all ages[7]. The vine of *F. tikoua* has strong flexibility and can grow both creeping and climbing. The stem bud has strong germination ability, with abundant lateral branches. The leaves of each stem segment are alternate or opposite, and remain green all year round, with better landscaping and horticultural ornamental characteristics. In addition, due to the strong rooting ability of stem and vine, *F. tikoua* can often touch the ground to take root, and coupled with criss-cross growth of vines, *F. tikoua* plays the role of sand prevention and soil consolidation, and can also be used as an excellent material for habitat restoration of highway slopes or park green spaces[8-9]. Hence, *F. tikoua* is a multi-purpose excellent resource plant integrating medicinal, edible, landscaping and ecological functions, and has important economic value and broad application prospects[3, 10].

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In recent years, research reports on *F. tikoua* at home and abroad mainly focus on the chemical composition of its stems and leaves and stress resistance characteristics[11-15]. Some scholars have also studied the landscaping, photosynthetic characteristics and fruit nutrition of *F. tikoua*[16-19]. Meanwhile, Wang Jiyue *et al.*[1] sequenced and analyzed the chloroplast genome of *F. tikoua*. Shi Denghong *et al.*[20] reported the transcriptomic analysis data of *F. tikoua*, and studied the differentially expressed genes in stems and leaves of *F. tikoua* based on transcriptomics. In addition, some scholars have studied the ecological adaptability, breeding technology and development and utilization of *F. tikoua*[21-25]. However, up to now, *F. tikoua* is almost still in the wild state. The technology of variety selection, introduction and cultivation and seedling breeding is immature, and *F. tikoua* has not been developed and utilized on a large scale. Based on the characteristics of *F. tikoua*, such as strong adaptability to the environment and fast breeding and reproduction, this paper explored the practical technology of large-scale and efficient breeding and reproduction of *F. tikoua* container seedlings from seedling bed construction, seedling collection, soil configuration, container selection, cutting seedling, field management and disease and pest control. The results can provide a reference for the establishment of germplasm collection nursery, introduction and cultivation, variety selection and bulk reproduction of container seedlings.

2 Scale breeding and reproduction technology of container seedlings

2.1 Seedling bed construction In order to facilitate the cultivation and maintenance of *F. tikoua* container seedlings and promote their rapid growth and reproduction, a flat plot should be selected as the large-scale breeding and reproduction base of container seedlings. The selected plot does not have high requirements for soil fertility, as long as it has good water retention, high breathability, and does not have too many stones or intertwined

tree roots. In order to improve the water retention and flood control and drainage function of seedling bed, the ground should be prepared before the establishment of seedling bed. Before the preparation of the land, herbs, shrubs, trees, stones and other debris in the plot should be removed thoroughly. Subsequently, the plots are evenly furrowed according to the north-south or east-west direction, with a width of 1.2 – 1.5 m and a spacing of 30 – 50 cm, while the length is flexibly planned according to the field conditions. Grooves are dug at the longitudinal interval, with a depth of 30 – 40 cm and a width of 20 – 30 cm, ensuring that the ridges on both sides of the groove are flat and solid. Then, the surface soil should be deeply ploughed and crushed, and the roots and gravels are further removed. Appropriately 15 – 20 cm soil is reserved as a ridge, and the ridge is fortified for subsequent walking and water retention and moisturization. The crushed soil is taken out to make the soil surface sink 15 – 20 cm and keep the bottom flat, which will facilitate the placement of nursery brackets. Hereto the construction of the "shallow ridge" seedling bed has been completed.

For uncultivated plots such as building land, barren slope lawns, and abandoned farmland for many years, it is also necessary to disinfect the soil surface with appropriate amount of quick lime after the construction of seedling bed to reduce the breeding of diseases and pests during the breeding and reproduction of seedlings. If the seedling base is a cultivated land and the soil of the cultivated land is yellow soil, brown soil or yellow brown soil, the ground soil that is deeply turned over can be sifted to remove gravels or large particles, and the fine soil can be retained as the seedling soil.

2.2 Seedling collection The seedlings are stem segments of *F. tikoua* vines growing naturally in the field. *F. tikoua* vines can be collected from grassland, sandy land, rocky and forest habitats, and 2 – 4 years old *F. tikoua* vines can be selected as cuttings. The current stem segments on the apex and lateral branches of the vine are removed with a pair of branch shears, and the obviously lignified stem segments are cut. The remaining stems are cut into 8 – 10 cm cuttings. Each cutting retains 2 – 5 stem segments, 2 – 4 axillary buds and 1 – 2 half leaves, which is convenient to reduce water evaporation after cutting. In addition, the morphological lower end of cuttings is trimmed into the shape of an oblique apex and the morphological upper end is sheared into the shape of a round head, which make it easier to insert into the soil and reduce the infection of apical wound.

2.3 Soil preparation Depending on the soil type of seedling bases, the crushed yellow soil, brown soil or yellow brown soil after land preparation can be used as the main components of combination soil for seedling cultivation. There is no need to re-cultivate or purchase special soil, which can effectively save costs. In this experiment, yellow loam soil, light substrate and humus soil are divided into different types of seedling soils in the following proportions: T1 (loam), T2 (loam ∶ light substrate = 1 ∶ 1), T3 (loam ∶ light substrate ∶ humus soil = 1 ∶ 1 ∶ 1), T4 (loam ∶ light substrate ∶ humus soil = 2 ∶ 1 ∶ 1), T5 (loam ∶ light substrate ∶ humus soil = 2 ∶ 2 ∶ 1), T6 (loam ∶ light substrate ∶ humus soil = 2 ∶ 3 ∶ 1).

2.4 Container selection The non-woven bag with a size of 18 cm × 18 cm × 20 cm (length × width × height) is selected as the container for plant growth of *F. tikoua* before soil loading, and the size of seedling bag after soil loading is 14 cm × 14 cm × 14 cm. The soil with the same combination ratio is bagged and placed onto the square seedling bag bracket, and each bracket contains 16 pots of seedling bag. Afterwards, the bracket is placed in the "shallow ridge" seedling bed box, and the soil surface of seedling bags is 3 – 5 cm higher than the ridge of seedling bed to avoid waterlogging damage. Selecting non-woven bag as a nursery container is not only cost-effective, breathable and moisturizing, but also environmentally friendly and degradable, and can also prevent seedling rot caused by rainwater deposition. The nursery bracket is convenient for the standardized management and maintenance of seedlings, and is also benefit for rapid seedling shipment.

2.5 Cutting seedling The cuttings of *F. tikoua* seedlings are soaked and treated with rooting powder solution for 15 – 20 min, and then inserted into the soil of seedling bags according to habitat types and soil ratios. The cuttings are inserted into the soil with the morphological lower end at a depth of 4 – 5 cm. The segment of morphological upper end is guaranteed to have 2 – 3 axillary buds or invisible buds protruding from the soil surface. Each pot of seedling bag can insert 1 – 2 cuttings, and cuttings of the same type of habitat and the same stem age are inserted in the seedling bags on the same bracket. In this study, Ginkgo Garden Teaching and Practice Base of Tongren University was selected as the pilot base for large-scale breeding and reproduction of *F. tikoua* container seedlings. The cutting seedling-raising was carried out from March to May of each year in 2020 – 2022. Temperature, rainfall and light from March to May of each year in the pilot base were the most appropriate for the growth and breeding of *F. tikoua*, and they were bred in near natural state.

2.6 Field management The breeding base of *F. tikoua* container seedling is an open field, and there is no need to carry out intertilling, soil loosening and thinning during the breeding period due to strong adaptability and fast reproduction of *F. tikoua*, low requirement of water and fertilizer and seedling growth in the container. Field management measures mainly include watering, weeding, fertilization and drainage. In the early stage of cuttage, if there is less rainfall, it can be assisted with artificial watering and moisturizing. Due to sufficient rainfall and high temperature in summer, the weeds grow rapidly and should be removed frequently. The number of weeds in the container is small and can be removed manually by hand. If cuttings are raised in summer, timely watering not only is conducive to orderly emergence of seedlings, but also can lower the surface temperature to avoid burns caused by high temperature or infection of pathogens. According to the rainfall and soil conditions of the base, the watering frequency and quantity can be determined. Sprinkling irrigation can be adopted, and the sprinkler irrigation interval is 7 – 10 d. The soil in the container should not be watered too much as long as it can be wetted. Intermittent sprinkling irrigation can be adopted, with small amount and multiple times. The fertilization of seedlings can be combined with sprinkling irrigation and watering. It is recommen-

ded to use all-vegetarian nutrient instant fertilizer (N ∶ P ∶ K = 10 ∶ 8 ∶ 7). Water and fertilizer should be sprayed at low intensity and high frequency, and fertilization can be reduced or stopped in winter. In case of continuous rainfall, waterlogging should be drained in time.

2.7 Disease and pest control The prevention and control of plant diseases and pests in the breeding and reproduction of container seedlings should adhere to the plant protection policy of "prevention first, green priority, comprehensive prevention and control", and agricultural control and physical control should be given priority, supplemented with chemical control. Agricultural prevention and control measures, such as strengthening field management, timely removal of diseased plants and disabled leaves, and improving ventilation and light transmission conditions, can be adopted. The yellow and blue board can be installed to trap and kill leaf miners and other adult insects. Appropriately 300 – 450 trap points can be set evenly per hm^2, and the layout points are fixed at 70 cm above the ground. High-efficiency, low-toxicity, low-residue and environmentally compatible pesticides can be used alternately in chemical control, and the spraying frequency should not be too dense. The spraying should be stopped before lifting of seedlings.

2.8 Seedling harvesting After 10 – 12 weeks of cultivation of container seedlings, the number of lateral buds, length of lateral branches, number and length of root system could meet the requirements of seedling emergence. Seedling emergence should choose rainy weather or the time when it turns cloudy after rain, in order to moisturize and loose soil and reduce the damage to seedling root caused by lifting of seedlings. When seedlings are lifted, they can be divided into bare root seedlings and container seedlings according to different transplantation purposes. Single pot non-woven bag seedlings are taken out, or the whole bracket can be taken out together. The soil in the non-woven bag should be watered and wetted in advance before lifting of bare-root seedlings, and then the seedlings are taken out, bundled and packaged. The containers and soil left after lifting of bare-root seedlings can be used repeatedly for cuttings. If the roots of seedlings have sunk into the soil at the bottom of the container, the exposed roots can be sheared. Temperature control and moisturizing transportation should be determined according to the transplantation season and distance of seedlings, and too long lateral branches or too dense leaves of seedlings must be trimmed off if necessary, in order to reduce the loss of water transpiration during transportation.

3 Conclusions

The test results showed that after 8 weeks of cultivation in the optimum loam soil of four different habitats, the cuttings in sandy habitat had more lateral buds, longer lateral branches and maximum number of roots (Table 1), indicating that *F. tikoua* vines in the sandy habitat were relatively more appropriate for large-scale cultivation and reproduction of container seedlings. For different soil ratios, the soil combination of loam ∶ light substrate ∶ humus soil = 2 ∶ 3 ∶ 1 was more conducive to the germination of more lateral buds, and better promoted the extension of lateral branches of *F. tikoua* seedlings and the formation of more root systems in sandy habitat (Table 2).

Table 1 Comparison of optimal reproduction parameters of *Ficus tikoua* cuttings in different habitats

Habitat type	Average number of lateral buds	Average length of lateral branches	Average number of roots
Sandy	10.63 ± 0.97 A	7.87 ± 0.32 A	18.17 ± 0.35 A
Grassland	9.33 ± 0.47 B	7.13 ± 0.57 AB	16.67 ± 0.96 B
Rocky	7.97 ± 0.38 C	5.83 ± 0.40 B	12.63 ± 1.32 C
Forest	4.53 ± 0.25 D	6.41 ± 0.30 B	9.93 ± 0.42 D

Note: Data represents Mean ± SD, different letters indicate significant differences ($P < 0.05$) in different habitats; the same below.

Table 2 Effect of different soils on the reproduction of *Ficus tikoua* seedlings in sandy habitat

Soil group	Average number of lateral buds	Average length of lateral branches	Average number of roots
T1	3.57 ± 0.31 D	4.17 ± 0.31 C	14.17 ± 0.31 C
T2	4.77 ± 0.42 D	4.77 ± 0.42 C	14.50 ± 1.25 C
T3	5.33 ± 0.40 CD	5.43 ± 0.61 BC	15.60 ± 0.62 BC
T4	6.33 ± 0.57 C	5.83 ± 0.35 C	16.10 ± 0.92 BC
T5	8.33 ± 0.40 B	6.60 ± 0.70 A	17.37 ± 0.35 A
T6	10.63 ± 0.97 A	7.17 ± 0.32 A	16.83 ± 1.33 AB

The results showed that *F. tikoua* segments in sandy habitat can be used as cuttings, and non-woven bag can be used as the container for plant growth. It can realize scale breeding and reproduction of *F. tikoua* container seedlings quickly by using the combination soil of loam ∶ light substrate ∶ humus soil = 2 ∶ 3 ∶ 1.

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(To page 23)

measures such as raising ducks under trees, setting up solar insecticidal lamps, hanging sticky traps, insect sex attractant, sweet and sour liquid can achieve twice the effect with half the effort.

7.2 Chemical control Drug control should comply with the national drug regulations. Mineral-based, plant-derived and biological agents are advocated, combined with the use of chemical pesticides permitted by the state (limit the use frequency, concentrations and safety intervals), while prohibited drugs should not be administered[11].

The main diseases of Qiuyue pear are mould core of fruits, scab and rust of leaves and dry rot of branches. 5° Be lime sulphur can be sprayed before germination to prevent dry rot. Polyoxins 600 times dilution should be sprayed once at the time of near flowering and 80% of flower abscission, to prevent mould core of fruits. Before and after bagging, thiophanate methyl or benzyl benzoate 1 000 times dilution can be sprayed to control scab and rust, which will receive good control effect.

The main pests include *Aphanostigma jakusuiense*, *Psylla chinensis*, all kinds of fruit moths, red spiders, *etc.* Imidacloprid, acetamiprid, thiamethoxam, lambda-cyhalothrin + thiamethoxam, abamectin, spirotetramat and matrine all have good control effect on *A. jakusuiense* and *P. chinensis*. Agents are usually sprayed to control *A. jakusuiense* before and after fruit bagging. Thiamethoxam, chlorfluazuron, abamectin and matrine can be applied to control all kinds of fruit moths. Agents must be sprayed from the beginning of germination as early as possible to control *P. chinensis*. Spirodiclofen and azacyclotin should be sprayed separately before and after bagging to prevent red spider. After harvesting, lime sulphur and petroleum emulsion are mixed to clear the orchard.

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(From page 18)

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