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Propagating jujubes

Rachelle Johnstone

Supporting your success
Introduction

Vegetative propagation of improved or selected cultivars is important to make Chinese jujube cultivation economically viable (Liu 2006). Like many other deciduous fruit trees, jujubes are often propagated by grafting two genotypes or cultivars together. There are two parts necessary for grafting: the rootstock, used for the root system; and the scion, the chosen cultivar or variety (Yao, 2016).

For successful grafting there are five important requirements (Hartmann et al, 1990):

1. **The stock and scion must be compatible** (usually different cultivars of the same species).
2. **The cambium layer of the scion must be placed in close contact with that of the rootstock.** The cut surfaces should be held together tightly by wrapping, wedging or other methods to encourage rapid healing of the graft union. This is so water and nutrients can be supplied to the scion from the rootstock by the time the buds start to open.
3. **Grafting must be done at a time when the scion and rootstock are in the correct physiological stage.** This usually means the scion buds are dormant while the cut tissues at the graft union are capable of producing callus tissue for healing the graft.
4. **Immediately after grafting, all cut surfaces must be protected from dehydration.** This is done by covering with tape or grafting wax.
5. **Proper care must be given to the grafts for a period of time following grafting.** If shoots are not removed from the stock below the graft this can inhibit the desired growth from the scion.

Grafting jujubes

Until recently Chinese jujube was propagated primarily by root suckers. More farmers in China now graft or bud onto seedling rootstocks. More than 95% of grafts take successfully if scion wood is coated with a thin layer of wax. Softwood grafting in early spring also gave success of 90% (Azum-Ali et al. 2006). Tissue culture has successfully been used for propagation but commercial production by this technique is still under development due to the requirements on high skill and expensive facilities (Liu & Wang 2009). Attempts to root hardwood cuttings have generally failed previously (Yan & Ferguson 1993), but there are some successful reports (Azum-Ali et al. 2006, Liu & Wang 2009).

Grafting tools

Basic tools required for grafting jujubes:

- Sharp grafting knife
- Secateurs for cutting scionwood and rootstock
- Hammer or mallet
- Grafting tape
- Labels
- Grafting wax (if using)
Rootstock

Rootstocks used in northern China are Chinese jujube and its direct ancestor sour jujube \((Z.\ acidojujuba)\) (Liu, 2006). Sour jujube is not permitted entry into Australia. In Western Australia, jinslin is used as a rootstock.

Suckers

Jujubes are known for having prolific offshoots or suckers, mainly on lateral roots with diameters of 5-10 mm (Figure 1). The use of suckers is a common method of propagation for jujubes (Liu, 2006).

Seed preparation for rootstock

Fully matured jujube stones and kernels (seeds) can also be used to grow rootstock seedlings (Liu, 2006). Jujubes have a hard stone containing two, one or no seeds, depending on the cultivar. For better germination the seeds should be removed from the stone before planting.

Rootstock fruit should be collected or purchased in autumn. The fruit should be soaked in water for several hours then the pulp removed until the stones are clean. The clean, dry stones should be kept in paper bags until stratification. Jujube seeds can germinate without stratification, but stratification makes germination easier and more reliable.

The stones should be stratified in moist sand for 3–4 months at 2–5°C before sowing. The stones are mixed with wet sand at a 1:3 to 1:4 ratios by volume and can be stored in pots or plastic bags (Yao, 2014). The seeds (removed from the stone) need to be soaked in water for 1–2 days (Liu, 2006).

Treated seeds are sown in early spring at a depth of 2cm, 10–15 cm apart within the rows and 40–50 cm apart between rows. Approximately 75–150 kg of stones or 20–
30 kg of seed is needed per hectare. Seedbeds can be covered with plastic film to promote germination (Liu, 2006).

**Rootstock seedling management**

Although jujubes are drought tolerant, adequate water supply in the nursery is essential. Pareek (2001) reported that maintenance of pre-irrigation moisture of 80% in the nursery soil has been helpful in the development of over 98% Chinese jujube seedlings (to be used for budding).

Seedlings should be fertilised regularly from when they are 7–10 cm tall to enhance growth. Once the plants reach 60 cm or so in height, trunk diameter growth can be encouraged by pinching the growing tip with your fingers and removing the lower branches to make grafting easier. Some of the seedlings should be ready for grafting after one year of growth and all plants should be ready after two years (Yao, 2016).

**Scionwood**

Due to jujubes unique shoot structure most of the side branches are not thick enough to be used as scionwood, making the primary shoots the most often used scionwood source. Each primary shoot only has 5 to 8 nodes that can be used for grafting. Due to the lack of scionwood, a single jujube bud piece is often used for grafting. One-year-old shoots are the best scionwood; however shoots up to three years old can also be used for grafting. Scions from 1–2 year old extension shoots have been very successful (Liu 2006, Liu & Zhao 2009).

**Scionwood Storage**

Waxing the scionwood is recommended to keep the wood from drying out if it is not going to be used for a month or more or if shipped from another location. Store the waxed or original scionwood (with some wet paper towels to keep them moist) in the refrigerator until grafting. If the scionwood is collected locally and will be used within 2 to 3 weeks, waxing is not necessary (Yao, 2014).

**Propagation methods**

Jujube wood is 2 to 3 times harder than other fruit trees like apple and peach. A sharp knife is required for jujube grafting. The method of grafting will depend on the size of the scion and rootstock and the time of the year (dormant or active growing season). By using a combination of grafting methods, you will be able to use most of your available scionwood and rootstocks of varied sizes. Most growers in Western Australia use wedge grafting or budding. Bark grafting or whip grafting is used in the United States (Yao, 2014). Cleft grafting is the preferred method in China (Liu, 2006).

**Wedge/cleft graft**

Wedge grafting is done in late winter or early spring before the bark begins to slip. The scion and the rootstock should have a similar diameter. The base of the scion is cut into a wedge shape. The top section of the rootstock is removed and a vertical cut made into the stem around the depth of the wedge. The wedge is carefully inserted into the cut, matching the cambium layer, which is the thin growing layer just inside the bark. The union is then wrapped firmly with grafting tape (Figure 2).
Figure 2  Wedge graft procedure: a) cut the scion to make a wedge; b) trim the top of the rootstock to match the diameter of the scion; c) make a split in the top of the rootstock; d) place the scion cut into the rootstock, matching the cambium layer on at least one side; e) wrap the graft union with grafting tape; d) seal the top end of the scion with grafting tape if in a hot climate to prevent drying out.

**Bark grafting**

As bark grafting depends on the bark separating easily from the wood it can only be done after active growth of the rootstock (Hartmann et al, 1990). The best time is a few weeks after bud break. It can be done later in the growing season, but less vegetative growth will be obtained.

With jujube’s thin bark and dense wood, several cuts are needed to expose a smooth, 2.5 cm or longer section of the scionwood surface. A small cut on the backside is then made to expose the cambium layer. Select a smooth surface close to the ground on the rootstock, remove the part above it with a horizontal cut, and make a vertical cut on the bark until you reach the cambium layer. Loosen the bark on both sides and slide the scion into it (Yao, 2014).
Wrap the graft union with grafting tape and make sure all the cut surfaces are covered. Make sure to wax/seal the top end of the scion or cover it with grafting tape if you live in a hot climate. Make sure you label the plant to identify the cultivar.

**Whip grafting**

Whip grafting can be done both in the dormant season and the growing season. When whip grafting, the diameters of the scionwood and rootstock must match.

It is particularly useful for grafting relatively small material (0.5 –1.5 cm in diameter). It is highly successful if done properly as there is substantial cambial contact, healing quickly and making a strong union (Hartmann et al, 1990).

The procedure involves cutting one side of the scion to make a smooth surface then making a back cut about 1/3 of the way from the top. A similar cut is then made to the rootstock and the scion is placed onto the cut and sealed or wrapped in grafting tape. See ‘Jujube grafting’ for more details and a video.

**Bud graft**

The best time for successful budding is during the active growth period. This is when the bark will easily separate from the wood in both the scion and rootstock (Azum-Ali et al).

**T-budding**

Successful T budding requires that the scion material have fully-formed, mature, dormant buds, and that the rootstock is in active growth. This means that the vascular cambium is actively growing, and the bark can be peeled easily from the stock piece with little damage (commonly referred to as the bark is ‘slipping’). If the bark is too tight that it has to be forcibly pried loose then the chances of the bud healing are poor (Hartmann et al, 1990).

T-budding is generally limited to stocks that are about 6 to 25 mm in diameter. The bud is inserted into the stock 5-25cm above the soil level in a smooth bark surface.

The bud and a small sliver of the wood underneath it are cut from the scion using an upward slicing motion. The cut should begin about 1-2 cm below the bud, and should go deep enough into the wood so that when the cut is finished about 1-2 cm above the bud.

Budding knives should be kept very sharp, so that as little damage as possible is done to the bud. Buds must be cut from the bud stick just prior to grafting, otherwise they will dry out.

A vertical cut is made on the stem of the rootstock. The cut should be deep enough to insure that the bark will separate at the cambium. A perpendicular cut is made at the upper end of the vertical cut to make a ‘T’. The bark is carefully slipped from the stem of the rootstock where the bud is placed. If the bark does not slip easily, this indicates that the stock is not in active growth and the process should be conducted later.

The union is then wrapped with grafting tape or budding rubbers. This closure must either breakdown by weathering or will need to be removed in 2 to 3 weeks after the union has healed.
Chip budding

Chip budding is a form of grafting where the scion is reduced to a small size with only one bud. It can be used when the bark is not slipping – early in the spring before growth starts or during summer when active growth has stopped early due to lack of water or other factors (Hartmann et al, 1990).

Figure 2 A successful bud graft

Management after grafting

- To avoid breakage from wind, the seedling should be tied to a support stick as it grows above 25 cm.
- Remove rootstock suckers after grafting.
- Water the grafted plants regularly and fertilise them when the scion is actively growing with a balanced NPK fertiliser.
- Maintain a weed-free area around the plants.
- Cut the grafting tape when the new growth is 1.2 – 1.8 m long.

Propagation from cuttings

Attempts to root hardwood cuttings have generally failed previously (Yan & Ferguson 1993), but there are some successful reports (Azum-Ali et al. 2006, Liu & Wang 2009). Softwood cuttings and root offshoot reproduction are quite common and successful (Liu, 2006).

Cuttings taken from root suckers before emergence give 76.8% survival. Root sucker differentiation from mature trees is 1000 to 15000 per hectare if 15 cm of the soil surface layer is removed in the orchard during March–April or September–October. Chinese jujube suckers when treated before stooling with 2500 ppm IBA gave 100% rooting in sand, 66.7% in vermiculture + perlite and 55.6% in soil medium but did not root when stooled without IBA treatment (Azum-Ali et al. 2006).
Micropropagation and tissue culture

Several micropropagation techniques have been carried out for in vitro propagation of jujubes including somatic embryogenesis, organogenesis and shoot tip culture (Yildirim et al, 2015). Micropropagation is mainly used as a technique for breeding new cultivars and other experimental research and not in a commercial capacity.

MS media supplemented with benzyl amino purine (BAP) alone and thidiazuron (TDZ) alone was not effective on in vitro micropropagation of jujube. TDZ and BAP were more effective to produce shoot from explants when used together. The highest percentage of explants that produced shoots and the number of shoots per explant were obtained from MS medium supplemented with 0.1 mg L−1 TDZ + 0.5 mg L−1 BAP + 0.1 mg L−1 IBA + 0.3 mg L−1 GA3. The highest rooting percentage (76.7 %) was obtained from MS and half-strength MS media supplemented with 2.0 mg L−1 IBA (Yıldırım et al, 2015).

A study by Dai et al. (2009) looking at different explants including stem tip, stem segment, leaves and embryo for tissue culture of Chinese jujube cultivars Lajiaozao and Dongzao found that: MS (Murashige and Skoog) medium could be used as basal medium for all above mentioned explants in Chinese jujube; The optimum kinds and concentrations of growth regulators in medium were quite different among explants. High concentration (about 0.5–3.0 mg/L) of 6-benzyl aminopurine (6-BA) plus low concentration (about 0.1–0.5 mg/L) of IBA were suitable for initiation and proliferation culture of stem tip and stem segment. Thidiazuron (TDZ) concentration of 1.0 mg/L was best for shoot regeneration from leaves. No or low concentration of growth regulator (0.1 mg/L 6-BA + 0.5 mg/L IBA + 0.1 mg/L naphthalene acetic acid) was fitted for 20–70 days old embryo culture; and 6-BA of low concentration (0–0.1 mg/L) and IBA of high concentration (about 0.5–1.5 mg/L) or indole-3-acetic acid (IAA) concentration of 1.0 mg/L were suitable for rooting culture of plantlet originated from different kinds of explants.

Conclusion

Jujubes can be propagated by various methods such as wedge/cleft grafting, whip grafting and bark grafting as well as budding. Local propagators have better success with budding but find that wedge grafting leads to a stronger tree. Most of the latest research into propagation is in micropropagation and tissue culture however this technique is mainly used for research and breeding new cultivars and not in a commercial capacity.

Grafting can be more of an art than a science. Much of the success of grafting depends on not only performing a technically correct graft but performing the graft at the proper time of year and management and care of the scion after grafting.
Acknowledgements

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