

Activity # 1- Assessing Horticultural Crop Suitability for the Queensland Murray Darling Basin Study Area

Specific Biophysical Crop Information – Chinese Jujube

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Activity 1 — Project Team

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Chinese jujube

Based on the biophysical requirements and limiting factors, Chinese jujube **is a potential crop** for the Balonne-Border Rivers Region of the QMDB. Market analysis of export potential and local market demand by variety and the ability to access planting material is a critical first step in assessing the commercial potential of this crop.

The Chinese jujube is a medium-sized deciduous tree, growing 7–10 metres high. The tree has shiny deciduous foliage and thorny branches. Jujubes are easily damaged by wind and should be netted to protect fruit from birds. The fruit varies in size depending on the cultivar, and it has a thin, dark red skin surrounding a sweet, white flesh. Western Australia is currently Australia's leading Chinese jujube producing state with an estimated 10,000 trees planted on 20 hectares. Chinese jujube trees have grown successfully in Australia for over 15 years, Western Australian interest and production began to increase in 2011 as awareness of the crop increased. In Western Australia, there are approximately 30 commercial Chinese jujube growers in the Perth Hills, the Northern Rangelands and the South West region. Small trial plantings exist in NSW in the Goulburn Valley and in South Australia. Chinese jujube fruits are eaten fresh, dried or processed and are also referred to as Chinese dates or red dates. **Queensland Fruit Fly (*Bactrocera tryoni*)** is a potential pest of **national significance to this crop in domestic and export markets**.

Crop Matrix:-

	Perennial Crop	Chinese jujube
Currently Grown (Y/N)	Qld	N
	QMDB	N
	NSW	Y
	Vic	Y?
Frost Sensitivity (Y/N or Deg C)	Seedling	N
	Growth	Y
	Reproductive	Y
Low Temp Sensitivity (Y/N or Deg C)	Seedling	N
	Growth	Y
	Reproductive	Y
High Temp Sensitivity	Seedling	N
	Growth	N
	Reproductive	N
Rainfall Sensitivity	Y/N	Y
	Growth Phase	Fruit maturity
Special Soil Requirements	Y/N	N
	Requirement	Well drained
Chilling Req.	Y/N	Y
	(Hours)	399-580 (Utah Scale)
Water Quality	Sensitivity (dS/m)	Will tolerate slightly saline water
Harvest Months	(Months)	February - April
Length of harvest	(Weeks)	8
First Harvest	(Years)	1
Full Production	(Years)	3
QMDB	Y/N	Y

Biophysical Requirements and Limiting Factors (climate)

Chinese jujube trees have grown successfully in Australia for over 15 years. The tree is well suited to Australia's climate and soil types, growing in a range of areas.

Temperature

The Chinese jujube **grows best in climates with a long, hot, dry summer** after adequate rain early in the season and cool temperatures during its dormancy.

Rainfall

The Chinese jujube has a **lower water requirement and higher salt tolerance than most fruit crops**. The tree adapts to drought conditions and not only survives but also produces reasonable yields under severe drought. Under natural conditions the tree forms a deep and substantial taproot making it drought tolerant. In Western Australia, jujubes are grown in areas with around 200–1000mm annual rainfall.

Soils

Jujubes **grow well on a variety of soils**. The tree prefers sandy loam or lighter soil but will grow on well drained clays. The jujube tree can tolerate saline, alkaline or slightly acidic soils. While they can grow in a range of soils, improvement of acidic, alkaline, salty and sandy soils will improve growth and production.

Irrigation

Jujube trees **can survive with very little water**, however, strategic irrigation can improve fruit set, reduce fruit drop and improve fruit size, yield and quality. Jujubes are known for their salt tolerance which varies between cultivars. In Western Australia trees have grown successfully using irrigation water with an electrical conductivity of 320mS/m.

The trees require approximately 3–8 megalitres per hectare (ML/ha) over the summer months.

Varieties

There are close to 1000 cultivars of Chinese jujube recorded in China and the number will increase continuously as new cultivars are developed and local traditional cultivars identified. There is enormous variation among cultivars which can be classified into five groups based on the use of the fruit: fresh; dried; candied; multipurpose and ornamental. In Western Australia around 15 recognised varieties are grown including Li, Chico, Don Polenski, GA866, Suimen, Thornless, Lang, Silverhill, Sherwood, Shanxi-Li, Redlands, Admiral Wilkes and Si-Hong. The main rootstock used is Jin-si-lin, grown from sucker beds, with the chosen scion variety grafted on using a cleft graft. **The varieties Chico and Li are most favoured fruit in the current local market.**

The table below and information that follows from the USA highlights the need to carefully investigate Chinese jujube varieties. The 10 leading varieties growing in China (Table1) do not match the 15 varieties being grown in Western Australia; this has implications for local variety selection and export potential.

Table 1 - The 10 leading varieties of Chinese jujube in China each producing 10 000 to 200 000 tonnes

(70% of total Chinese jujube production)

Cultivar	Use	Main producing area
Dongzao	Fresh	Hebei, Shandong
Linyilizao	Fresh	Shanxi
Pozao	Dry	Hebei
Changhongzao	Dry	Shandong
Yuanlingzao	Dry	Shandong, Hebei
Muzao	Dry	Shanxi, Shanxi
Bianhesuan	Dry	Henan
Jinsxiaoza	Dry, Fresh	Hebei, Shandong
Huizao	Multipurpose	Henan, Xinjiang
Zanhuangdazao	Multipurpose	Hebei, Northwest



Figure 1: A jujube orchard in York (W.A.) showing the difference in growth habit of the Li variety (left) and Chico variety (right).

Source: RIRDC Publication No. 14/001

Chinese jujube in the USA

In the 1920's the United States Department of Agriculture released several varieties to industry with little information on exactly what to do with the fruit. They thought that all fruit was good to be eaten fresh off the tree when it ripened. The Chinese, on the other hand, had developed the improved jujubes for several purposes. The first and foremost was to make dried dates from the fruit, and varieties intended to make dried fruit were not suitable for eating fresh. These lines have a sweet but dry tasting fruit when picked fresh from the tree. The Chinese did have jujube varieties that were very good for fresh eating but only one of these varieties was imported and distributed by the USDA. Most of the varieties introduced were for drying or other processing. This resulted in the jujube getting a bad reputation amongst early growers. The one variety that was intended by the Chinese as a multipurpose variety, including fresh eating, is 'Li'; but it is not the very best for the purpose. One variety developed by the USDA in the 1950s was originally called 'GI 7-62,' referring to the place in the row of trees being tested. Fruit growers gave it the name 'Chico' in memory of the abandoned Fruit Introduction Station at Chico, California. Then, there is the 'Yu' variety that was renamed 'Silverhill' and renamed again as 'Tigertooth,' the name that is currently in use. 'Tigertooth' can be grown in areas that have high humidity (most jujubes like dry weather).

It was not until the 1990s that the first good tasting fresh eating Chinese jujube varieties were imported into the United States. Since that time other good fresh eating varieties have been imported into the USA, including two that were released for sale in 2007. These new varieties are suitable for fresh consumption, however the varieties intended for drying taste very dry and mealy when eaten fresh.

In the USA the better varieties for fresh use are 'Honey Jar,' 'Sugar Cane,' 'Li,' 'Shanxi Li,' 'Sherwood' and 'Chico' ('GI 7-62'). Of these the largest is 'Shanxi Li' and the smallest is 'Honey Jar.' 'Honey Jar' is the juiciest. 'Chico' ('GI 7-62') matures in mid to late season and 'Sherwood' is the last of these to ripen in early October. 'Li,' 'Shanxi Li,' 'Honey Jar' and 'Sugar Cane' ripen in August and early September. Information from Texas (USA) suggests the variety called 'Winter Delight' is a good variety; at least in China it is considered a top variety.

The best drying varieties are 'Lang,' 'Li' and 'Shanxi Li.' But any jujube can be dried. The smaller varieties do not dry well unless you are very careful and watch them closely so that they do not get too dry. You want them spongy, not hard as rock, for a good dried jujube.

For processing, any jujube variety can be used. If you are making whole pickled jujubes, 'Chico' makes a nice looking finished product. Jujube butter can be made from any jujube, using fruit that is in the yellow-green stage of maturity.

Nearly all Chinese jujubes are self-pollinating, meaning that you only need one tree to produce fruit; however, there are a few varieties that need cross-pollination to maximise cropping potential.

Most jujube trees purchased from a nursery are grafted onto wild jujube rootstock. These wild rootstocks tend to sucker and will send up plantlets several feet away from the tree. Some varieties have more thorns on the stems than others

Chilling

A comparison was made of the chill hours experienced at Chinese jujube production sites in Western Australia with key locations in the QMDB study area. Chill hours were calculated using the methodology of Leudeling et al. (2013) to convert from daily minimum and maximum temperature to hourly for York, Giddegannup and Bindoon and key locations in the QMDB study area. Meteorological data was obtained from the SILO database (long.paddock.qld.gov). This data is based on observations made by the Bureau of Meteorology and is in-filled with interpolated data for missing values and where instrumentation is lacking. Temperatures were only recorded at York, so the other two sites used the in-filled data. However, additional temperature data from Pearce RAAF base for Giddegannup (22 km away) and Gingin Aero for Bindoon (23 km way) has also been utilised, as these are the nearest stations that record temperature. There is some discrepancy between Pearce RAAF base and Giddegannup.

Chill Hours Comparison of Western Australian Chinese Jujube Sites and Sites in the QMDB Study Area

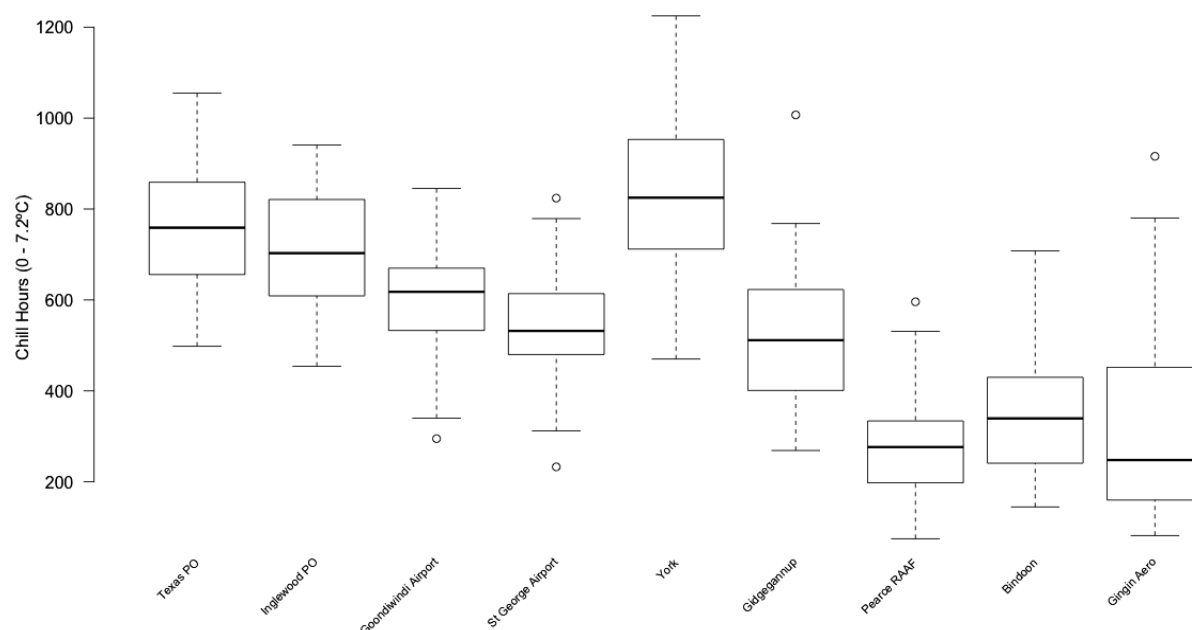


Figure 2. Boxplot showing the median chill hours (centre line) and the boxes the 25-75% range for comparison Australian locations.

Table 2 - Chill hours comparison calculated with the chillR package using BoM and SILO data.

Chill Hours, 25th, median and 75th percentile of chill hours (1957 - 2014).									
Calculation based on number of hours ≥ 0 and $\leq 7.2^{\circ}\text{C}$									
Chill Quartile	Texas Post Office	Inglewood Post Office	Goondiwindi Airport	St George Airport	York	Gidgegannup	Pearce RAAF	Bindoon	Gingin Aero
25%	656.75	609.25	535.25	480.5	712.5	405	199.5	241.25	161.75
50%	759	703	618	532	825	511.5	276.5	339.5	248
75%	858	818.75	669.5	613.25	951.75	621.5	334	429.75	445.25

This table has the 25, 50 (median) and 75 percentiles for Chill Hours ($0-7.2^{\circ}\text{C}$) for the 58 years 1957 to 2014. Interestingly, the range for Gingin Aero is 162 to 445 CH, that is 25% of years were below 162 and 25% were above 445.

Chill hours comparison methodology reference: Luedeling E, Kunz A, Blanke M (2013) Identification of chilling and heat requirements of cherry trees—a statistical approach. *International Journal of Biometeorology*, 57, 679-689.

Project team member Dr Neil White, DAF, Toowoomba, undertook the calculation of chill hours and provided some of the figures.

Pollination

While most cultivars are self-fertile, pollination can be enhanced through the introduction of bees. Pollen is sticky and therefore wind pollination is ineffective. Pollen viability is low in most cultivars. Jujube trees typically have abundant flowering but low fruit set. Heavy fruit drop occurs after fruit set, caused by lack of fertilisation or degeneration of the ovule. Soil moisture stress, low relative humidity, lack of sunlight and strong winds during fruit maturity can also lead to fruit drop

Crop Lifecycle

Jujube fruit matures from February to April in Western Australia. Immature fruits have green skin and will not ripen if picked. Fruit picked later will continue to ripen after harvest. The fruit can be left on the tree to be picked when dried. Fruit maturation of Chinese jujube can be divided into three phases; white mature, crisp mature, and fully mature.

Chinese Jujube – Overview

Chinese jujube has been **introduced to more than 30 countries** and has become commercially cultivated fruit tree in South Korea. In 2006, its total growing area in China was approximately 150 million ha with production of 3.05 million tons on a fresh weight basis, accounting for 99% of world production.

Orchard Establishment

Conventional jujube orchards are planted at spacing's of 4–5m x 5–6m.

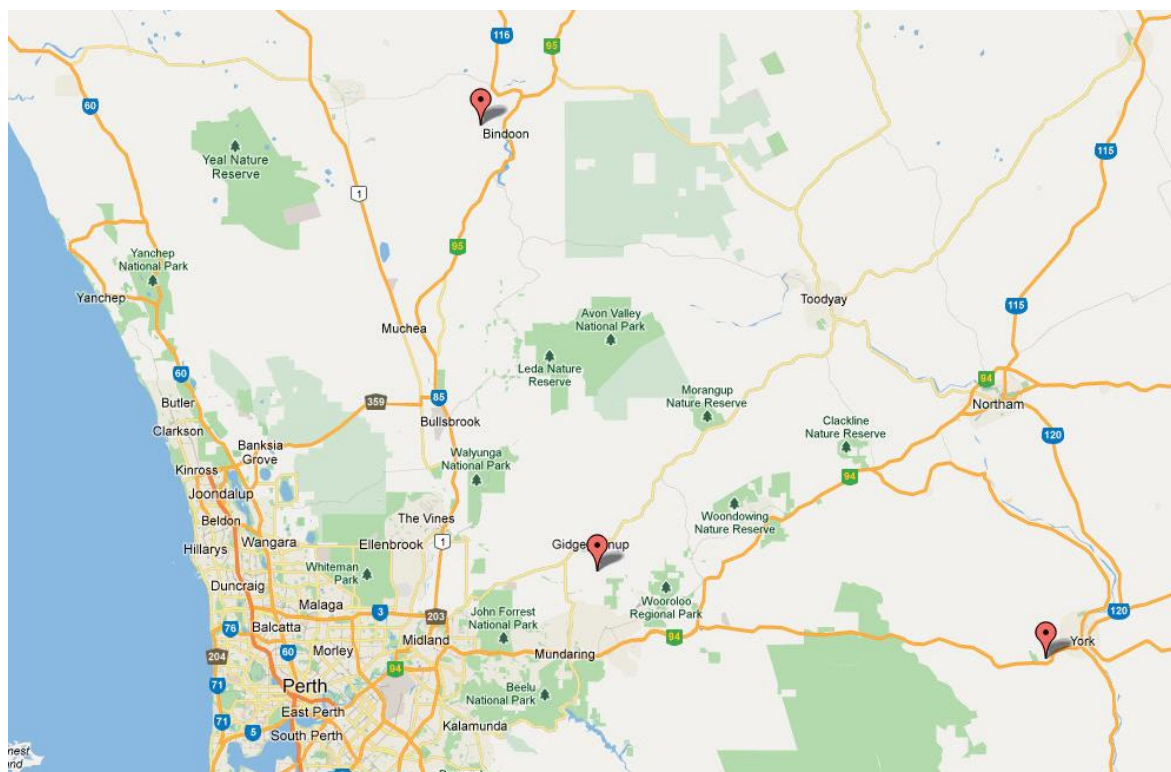
In China, intensive orchards are planted at 2–3m x 3–4m, 1m x 2m in planned intensive planting, 0.5–0.7m x 1m in super-intensive plantings and protected plantings in greenhouses. In WA the number of trees planted per hectare ranges from around 550 to 1000

Jujube trees can be **damaged by winds so windbreaks are advised** if the site is susceptible to strong prevailing winds. Netting is recommended to protect jujube orchards from birds, rabbits and kangaroos.

It is estimated that establishment costs for a one hectare netted jujube orchard with drip irrigation (including pump, main and sub lines and installation) is over \$90 000. In the current market (2014) it is estimated that it would take seven years until cash flow becomes positive.

Comparison Region(s)

Figure 3: Chinese jujube production sites in Western Australia.



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Disclaimer: The candidate crop information presented in this QMDB study area report (Activity 1) are based on the analysis of the published biophysical needs of the crops (e.g. temperature, frost sensitivity, chill requirement, water quality, etc.) and current climate records for the QMDB study area. The candidate crops are deemed suited to the study area where the biophysical needs are met either year round or for portion of the year and will allow crop production.
