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Overview of *Simmondsia chinensis* (Jojoba shrubs) Cultivation and Propagation Methods



Waleed Fouad Abobatta*

Citrus Research Department, Horticulture Research Institute, Egypt

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*Corresponding author: Waleed Fouad Abobatta, Horticulture Research Institute (HRI), Agriculture Research Center (ARC), 9 El-Gamaa St., Giza, Egypt

Abstract

Jojoba plants (*Simmondsia chinensis*) is an excellent plant for development marginal lands, Jojoba propagate by different vegetative methods including (stem cuttings, grafting, air-layering, root cutting and tissue) or direct seed propagation. Jojoba cultivated for it is valuable oil, this oil used in various industries such as pharmaceutical products, cosmetics, produce biodiesel fuel as well as biodegradable lubricants, jojoba considered as a new solution of bio-fuel in coming era.

jojoba has a deep-rooted system can extract water, therefore, it is adapted to drought and salinity conditions, it can persevere where several conventional crops cannot survive, so, it is growing and produce economic crop in marginal lands and offer promise for cultivation under harsh conditions. This work aimed to explain important of jojoba, propagation methods and some usage of jojoba oil.

Keywords: *Simmondsia chinensis*; Propagation methods; Jojoba oil; Biofuel

Introduction

Jojoba *Simmondsia chinensis* (Link) (pronounced hohoba) is an evergreen perennial shrub, jojoba has numerous names in several regions of the world, such as bucknut, coffee nut, goat nut, pig nut and lemon leaf [1]. In recent years, there has been considerable interest in development arid and semi-arid lands by promoting crops which can tolerate these conditions such as *Jatropha curcas* [2], and jojoba (*Simmondsia chinensis*) [3], Jojoba is a multipurpose crops, and have a potential use for rehabilitation of the marginal lands, also, Jojoba is a high-value shrub and a promising cash crop, it is considered a source for the provision of income to the pastoral communities [4], it is produces high quality oil used in cosmetics, lubricant industry, pharmaceuticals and electronics [5].

Jojoba could tolerant drought and salinity conditions, it is adapted to the aridity conditions, also, it is grown and produce economic crop in marginal lands, jojoba has deep-rooted system can extract moisture from a wide area of soil and, it can persist where several conventional crops cannot survive; it offers promise for agriculture in harsh conditions. jojoba produce small seeds, which has liquid wax considered the nearby vegetarian oil to sperm whale in value, the main usage for jojoba oil mostly in the manufactories pharmaceutical products, cosmetics, and used as lubricants in the motor industry, besides that, it is use to produce bio-fuel. Nowadays, jojoba is cultivated as an economic plant in various regions of the

world like Egypt, Argentina, Australia, India, Mexico, Peru, Kenya, Brazil, South Africa, Costa Rica, Paraguay, Chile, Iran, and Israel, due to its high commercial value [6].

Botanical

Jojoba *Simmondsia chinensis* is the sole genus (*Simmondsia*), in family *Simmondsiaceae*; which contain the only species in this genus (*jojoba-Simmondsia chinensis*) (Link) Schneider. Jojoba is a perennial evergreen dioecious with male and female plants, depends on wind for successful pollination [7]. It is a shrub or small tree variable in height from 0.5 to 3 meters (Figure 1) with dense round crown, also, jojoba has many main stems and sometimes it is growing desperate subjected to its environment.



Figure 1: Field Image: Jojoba farm in Egypt 2017.



Figure 2: Jojoba leaves.

Jojoba leaves have an oval shape, with 2-3cm long and 1.0 -1.5cm broad, the leaves are opposite, thick waxy grey-green in color (Figure 2), also, jojoba plant has a deep root system can reach more than 15m depth [8], deep-rootedness habit helps it to reach to tap water from deep aquifers for its existence under dry conditions and also to extract the leached nutrients from the deep layers of the soil which plant use to survive under harsh conditions. In the origin jojoba natural life prolongs to more than 100 years and may extend up to 200 years.

Flowering and fruiting

Jojoba is dioecious plants with separate male and female plants, flower buds growing on the fresh vegetative shoots, it is formed in the axils of the leaves during the warm period of growth, jojoba flowers are greenish-yellow, with 5-6 sepals without petals, the female flowers grown and bloom single auxiliary (sometimes twice flowers) at alternate nodes, it has light green color with long pedicles, the male flowers are bigger than female one with yellow color and grow in bunched contain 7 or more flowers at nodes [9], generally there are no female petals or scent to attract insects, jojoba pollinated by wind. In the northern hemisphere flowering began from March to May depend on fulfillment of chilling requirements and winter rains.

Chilling requirements

Due to jojoba native in arid area, it needs low chilling requirements (average from 15- 20 °C) for short period about a month for break flower dormancy to start flower induction in jojoba [10], therefore, exposure flower buds to enough cold units and fulfillment of their chilling requirements during winter improve the flowering and total yield of jojoba plants [9].

Soil type

Jojoba is grown in a different type of soil, but preferable cultivated jojoba in well drainage light soils, sandy or gravely soils, with a pH ranged from 5 to 8.5 [11], soil pH not an very determined factor for jojoba cultivation, Jojoba prefers very sandy soils with low organic matter (Figure 3). However, in clay soil drainage is critical element for jojoba growth and productivity, also, water-logged in heavy clay soils may be execute plants, it is need well water penetration, therefore, jojoba grew and flowering slower in heavy soil than light soils, also, preferable avoiding cultivated jojoba in heavy clay soil [6].



Figure 3: Field Image: Jojoba farm, North of Egypt 2018.

Jojoba nutrition

Poor management of the existing Jojoba bushes has led to low production of seeds (0.5-2kg/bush) through severe abortion of flowers and pods. This is mainly through competition for nutrients, water and space [12]. Jojoba grows on soils of marginal soil fertility, fertilization of field plots with nitrogen and phosphorus improved plant growth and increase seed production. In marginal lands preferable added some organic fertilizers for plants (about 1kg compost with ¼ kg of super phosphate and ¼ kg of sulfur/adult tree) from mid of November till January, low nutrition of jojoba trees reduce seed production through abortion of fruit set and drops of fruits before maturity [13].

Water requirement

Jojoba is native to the arid zone of Sonoran desert with harsh climatic conditions, therefore, Jojoba plant is drought resistant, the water requirements for jojoba is very low compared to other crops like maize and grape, it is needs little water for survival, the ideal growth and economic productivity of jojoba require rainfall average of 254 to 380mm annually, consequently, under low rainfall conditions (254mm or less) supplementary irrigation is required particularly during establishment the orchards and the first year after cultivation and to get healthy trees in arid areas [6], also, jojoba could tolerate soil salinity more than other crops, so, treated sewage water and saline water could be used to irrigate jojoba plants.

Economic consideration dictates that supplementary irrigation is essential for a healthy tree and sustained high annual crop in arid and marginal areas. Irrigation water supply with relatively good drainage stimulated more luxuriant vegetation and good flower production and, thus, good seed yield.

Climate

Jojoba naturally grows in marginal areas with rainfall ranging between 220-350mm yr⁻¹, jojoba cultivated when soil temperatures are 20 °C, and the optimum temperature average for growth and productivity between 27-33 °C [14], but jojoba flowering require low temperature about 15-20 °C for a month at least to break flower dormancy, from other side, jojoba tolerates high temperatures without negative effects on plant growth up to 54 °C (122 °F).

Jojoba cannot resist frosts below -3 °C for long time, particularly during flowering stage, cold weather could destroy flowers

completely, new flushes and terminal portions of young fruit set, however, new plants cannot tolerate excessive cold temperature during early seedling development and may extinguish whole plantations, and however, mature plants could withstand during cold weather than the new establishment plant, therefore, temperature may be the most critical factor in growing jojoba.

Propagation

Jojoba could propagate by different way, vegetative propagation including (stem cuttings, grafting, air-layering, root cutting and tissue) or seedy propagation technique [15].

3.8.1. Vegetative propagation methods: Vegetative propagation use to avoiding high male to female ration in jojoba farms, and use determined plants ratio, there is various advantages of using vegetative propagation methods in commercial jojoba plantations like they produce genetically uniform plant, and early fruiting [16], it is allow growers to decreasing cultivation expenses, use the proper ratio of female to male plants according to cultivation plans, and plants start produce seed crop earlier than seedy plants. There are various asexual techniques used for jojoba propagation, such as;

a. Stem cuttings: Rooting of stem cuttings is the main adopted technique used for vegetative propagation, dormant stage considered the best time to take stem cutting to increase successive ratio, (Figure 4), due to high carbohydrate to nitrogen ratio (C/N ratio) in this period, also, preferable use stem cuttings with 4-5 nodes [17], beside that rooting hormones like NAA or IBA improve root formation [18], also, semi-hardwood cuttings, and single-node cuttings (double-eye or Single -eye) could use under controlled conditions.



Figure 4: Stem cutting.

b. Grafting: Grafting technique of jojoba has various advantages particularly in seedy cultivation by using the deep root system of male plants as rootstock grafted with Scions of mature female plants previously known as high yield with good fruit quality properties, August and September considered proper timing for Veneer grafting [19], also, preferable use scions from mature wood, grafting help to survive plants under stress conditions (drought, salinity, and malnutrition) by use scion of desirable plants which will allow predictable plant vigour and high crops, also reducing juvenile stage of jojoba plants particularly males plants which produce seeds in two years approximately [20].

c. Tissue culture: tissue culture technique provides opportunities for the production of thousands of finest plants from the selected trees, Jojoba plants from tissue culture grow more vigorously than other seedlings (Figure 5), regularly, shoot tip or nodal segment used as explant source, could conceivably provide thousands of new true to type plantlets per year [21], but till now jojoba propagation by tissue culture still in research field only.

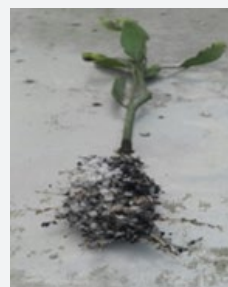


Figure 5: Tissue culture method.

d. Roots cuttings: This method has not been used commercially for some reasons like shortage of plant materials as sources of cuttings; also, this technique need controlled conditions facilities to produce new plants and it is slowly proceeding for commercial production.

Seed propagation method: seed propagation is easier and low-cost methods but there are negative effects like produced more male plants than female plants (average 1:1 up to 5:1 male to female plants), this cause low crop production due to more than 50% of plants are nonproducing, also, the females start production in the fourth or fifth year, and there are many female plants are produce very low crop with low quality [22], also, there are heterogeneity differences between seedy plants which affect growth uniformity, physiological characteristics, yield and early bearing [23], therefore, after flowering grower must remove exceed males and the poorer female plants from the farm and replanting new plants which delay economic production.

Yield

There have been considerable yield differences between seedy trees and asexual seedlings in total production and seed quality. Jojoba fruits are green capsules 1-2cm long, with three-angled at a corn-shaped ovoid, capsule partly enclosed at the base by the sepals, the fruits turn to brown color on maturation period.

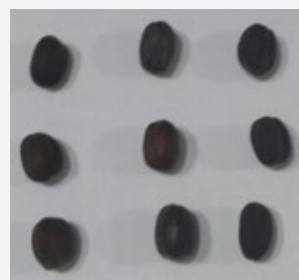


Figure 6: Jojoba seeds.

The mature seed is a hard oval, or slightly spherical, brown in color (Figure 6) and contains oil (liquid wax) content of 40-50% approximately, there is variation between seeds in shape, size, and weight of seeds, regarding farm management practice [24].

Harvesting

Jojoba shrubs regularly start flowering and seed production in the second or third year after planting [10&14], and seeds ripen during the summer, however, seedy cultivation starts production from the fourth or fifth year.

In marginal lands jojoba are harvested manually, in other regions seed collected manually and mechanically after they have fallen to the ground, jojoba seeds could remain for a long time on the ground without negative effects, unless there are rodents are active in the cultivation area, so, it needs quick harvested to avoid losing the crop seeds.

Oil Content: Jojoba oil is a soluble wax; it includes esters of high molecular weight monounsaturated fatty acids and alcohol and various components of sterols and vitamins [25], Jojoba oil could transform to hard white wax by hydrogenation, it has a very long straight-chain wax ester (C36-C46) and not a triglyceride [26], this oil has unique properties to use in various industrial and medicinal uses, this characteristics of gave more attention to this shrubs.

Jojoba uses

Jojoba considered versatile plants, and it is a promising cash crop for the poor communities, also, have a potential use for rehabilitation particularly in marginal regions, Jojoba is a proper plant to combat and prevent desertification in arid regions such as in India (Thar desert area) [27], and in Egypt around 6 October city [5].

Concerning jojoba oil there are numerous applications in pharmaceuticals like a number of skin and scalp disorders, skin emollient [28], anti-acne, anti-psoriasis [29], anti-inflammatory [30], and anti-hypercholesterolemia [31], also, it is used in cosmetics products and in various fields like polishing, and gardening applications, from another side, jojoba oil is used to produce a biodiesel fuel, and as biodegradable lubricants, it is a new solution of fuel in coming era [32]. Also, Jojoba meal could use for producing bioenergy [33], or other useful products like animal feed (Figure 7).



Figure 7: Egyptian Animal feed from Jojoba meal.

Conclusion

Jojoba shrubs is a proper plant to sustainable development for the poor area and rehabilitation marginal regions, jojoba grown in different types of soil and resist drought and salinity conditions more than other plants, it is easily propagated by both vegetative and seedy methods, also, there are a few pests and diseases affect jojoba shrubs productivity. Jojoba oil considered raw materials for various industries in pharmacology and cosmetics production, also, it provides a new source for biofuel and biodegradable lubricants; however, jojoba meal used for animal feed production or bioenergy and other useful products. Therefore, Jojoba has a promising future for developed dry and marginal lands, it is offers an excellent opportunities in various sectors.

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