DOI: https://doi.org/10.24297/jaa.v10i0.8145

Jatropha curcas: an overview

Waleed Fouad Abobatta

Horticulture Research Institute, Agriculture Research Center, Egypt

wabobatta@yahoo.com

Background

Jatropha curcas L. belongs to family Euphorbiaceae, Jatropha curcas is a valuable multi-purpose crop, historically it was used as medicine for wounds and leaves used as drinks against malaria, jatropha plants used to control soil degradation, alleviate erosion, desertification and increase soil fertility, however, in last decades there is more attention to use jatropha oil for produce biodiesel, Jatropha curcas is easily propagated by seeds or stem cutting, it is tolerant for drought for longtime, it is grow well with treated wastewater, also, it can be grown on marginal land. Jatropha curcas seed have about 32-40% valuable oil used to produce biofuel, therefore, it could be the source for biodiesel production particularly in arid and semiarid regions.

Keywords: Jatropha curcas, marginal lands, treated wastewater, biodiesel.

Introduction

Jatropha curcas a woody shrub, it is one of family Euphorbiaceae, it is most widely specie across different regions all over the world due to its strength, It has many names in different regions like the physic nut, goat nuts, (pinhão-manso in Brazil), Barbados nut, purging nut, nettle spurge, or just Jatropha [1], previous researches showed that jatropha is native to Central and South America [2].

Jatropha curcas is appropriate for growth under adverse conditions, like drought, low nutrient supply and salinity [3], also, jatropha may be a proper solution for biofuel production from cultivation irrigated with treated wastewater [4]

Jatropha considered a multipurpose plant, it has been used in traditional human medicine and for veterinary medicine for over a long period of time [5], it can decrease soil degradation, desertification, and deforestation [6].

There are more interesting about jatropha from the last decades use jatropha oil as a main source for biodiesel production instead of edible crops [7], also, it is to combat desertification and reduce soil erosion in arid regions, Jatropha has great yield potential and can be grows well under stress conditions, and it is claimed to be drought resistant and can be grown under salinity and on marginal lands conditions.

The notable important of Jatropha curcas L. as biofuel crop, due to its seeds bearing 32 to 40% oil content, that can be simply converted into bio-diesel, consequently, it has high potential to be used in biodiesel production [8-10].

Biodiesel obtained from jatropha provides international standards[11], jatropha had great adaptability to arid and semi-arid environments [10], prober for wasteland reclamation, explanatory environmental stress, supporting socio-economic [12], short maturation period and being inedible to grazers, also, *Jatropha curcas* is also being studied for use as a carbon sequestration plant in arid regions [13], Jatropha oil cake is rich in NPK and can be used as organic fertilizers[14].

Jatropha has been emerged to farmers in arid and semi-arid regions as a promising renewable energy crop, and a new economic crop for poor soil or marginal lands, and it is good adaptation to different agro-climatic conditions [15], the physiological characteristics of jatropha, associated with its economic prospective put it into an alternative biofuel plant for arid and semiarid regions [16].

For all the above-mentioned advantages and applications J. curcas remains a favorite feedstock for produce bio-diesel and highly desirable for growing on marginal lands.

Figure 1: Field image for Jatropha orchards in Egypt

Botanical:

Jatropha (*Jatropha curcas L.*) is a deciduous oilseedm shrub, Jatropha genus one of Joannesieae tribe, as a member of Crotonoideae in the Euphorbiaceae family; native to tropical America [8&17], and mature Jatropha (more than 8 years old) reach to 7 -13 meter height (Fig. 1), the leaves are green, thick and the length is 8.55 cm long and width about 5 cm, with heart-shaped, with long neck reach to 11 cm long, Jatropha has small greenish yellow flowers, and the fruits are green at first stage and yellow to brown on ripening. Fruit contains often 2 - 3 oval black seeds, the seed contains kernels and shells, kernel contain protein (22% - 28%) and high oil content (ranging from 32% - 40%) according to the growing conditions and genotype [18].

Flowering and pollination:

Jatropha curcasis a monoecious plant; Inflorescences produce on terminals of branches and contain both the male and female flowers, male flowers surrounded central female flower , J. curcas produce small greenish yellow flowers, usually, the flowers are unisexual, only a few male flowers are produced in each inflorescence, all flowers were open at the same time (both female and male), therefore, cross-pollination could be between flowers from the same plants or from other plants, female flowers and buds are somewhat larger than the male flowers, soil moister and proper temperature considered as promoting factors for Jatropha to have two crops during the year [19]. under Egyptian conditions jatropha curcas flowering twice time in the year, first one in April, the second one harvested in December [20].

Fruiting and seed Maturity:

The fruits are approximately 2.5 cm long and contain three black seeds, it is reach to complete size after 90 days from pollination date approximately, divided to 30-45 days after pollination, (Fig. 2), yellow fruit stage (mature 45- 60 days) however, ripened stage start after 60 days approximately [21]

Figure 2: Jatropha fruits at different stages of maturity (8)

Yield and Crop production:

There are various factors affecting crop production of J. curcas, the total yield can be improved through efficient use for water requirements and fertilizers, therefore, water shortage and poor supply of nutrients at critical growth stage seems to be the key factor reduced the crop production [22]. Also, the number of branches formed and main spike length considered major factors in increasing the number of fruits and affects the total number of capsules, seed yield, and seed oil content. Under Egyptian

conditions Jatropha produce fruits twice time per year, first one in June and the second in late December, previous literature reported that total seed yield of mature J. curcas varied from 0.2 t ha−1 to 12 t ha−1, depending on production conditions and genotype [11].

Propagation:

J. curcas is easily propagated by seeds or stem cutting; also, it propagated through tissue culture technique, it has a short period of growth until the first fruit harvest [23]. The planting material should be taken from carefully chosen from healthy vigor with higher yield potential tree.

a) Propagation from seed:

Using selected seeds from mature tree that have high yield and seed oil content, also, preferable sown seeds in nursery beds to provide better germination and survival ratio through control local environmental conditions during seedlings growth before planting in the field [18], however, other growers sown seeds directly in the field, in this case must use more seeds due to decreasing in survival rate to less than 50% [24].

b) Vegetative propagation using cuttings:

Using cuttings is preferable due to different advantage such as their genetic uniformity, fast establishment, early yield, and the higher survival rate, cuttings taken from the middle or lower parts of branches of previous year old in length from 25-40 cm, and planted in polybags or seedbed to improve survival ratio [25& 26]. Also, plants from cutting gave earlier and higher initial yields than plants grow up from seed [27].

c) Tissue culture:

Growing plantlets from tissue culture used for researched and scientific purpose, till now there is no commercial production for jatropha curcas recorded.

Fertilizing:

Use of fertilizer could be a key to improve Jatropha productivity, Jatropha fertilizing start from the second year after establishing, fertilizers increases the efficiency of irrigation water, also, it is increased the turnover cost of cultivation, at the time of plantation some fertilizers must applying in planting pit to provide essential nutrients for plants, It is necessary to continue the supply of NPK fertilizers as a proper quantity in the soils to exploit full potential of jatropha [19]. Unfortunately, till now there is a lake on proper fertilization program for Jatropha curcas.

Irrigation:

Jatropha considered a drought-resistant plant and there are many previous researchers have investigated the performance of J. curcas under dry environments [26]. Jatropha water requirement is very low and it can resist drought conditions for long time by dropping their leaves to reduce transpiration rate, while, deficit water quantity decrease tree growth and leaf development [28].

Several research papers have also reported drought induced reductions in growth and yield of Jatropha plants under various growing conditions [29].

Jatropha cultivation:

Transplanted seedlings of J. curcas into the field on March or October, before cultivation, each plant need preparing a 45 cm x 45 cm x 45cm sized pit at a determine spacing depending on tree spacing and tree density,

it could be 2.5 m between trees and 2.5 m within rows, giving plant densities of 1600 plants ha-1, or 2.5 m between the tree and 3 m within the row with 1330 plants ha-1. Jatropha grew rapidly until October, and shed their leaves during autumn and stayed dormant during the winters till next February [28]

Soil and Climate:

Jatropha grows in a variable region with cultivation limits at 30ºN and 35ºS, also it could grow at altitudes up to 500 meters above sea level, it is needs temperatures between 20˚C and 28˚C, however, very hot climate depress flower fertilizing and total yields, also, Jatropha cannot tolerate cold weathering.

Jatropha curcas can grow in arid and semiarid region; it is growing will in aerated sandy loamy soil of at least 45 cm depth [30], Jatropha had the ability to grow in alkaline soils but within soil pH from 6.0 to 8.5.

Jatropha could grow in heavy clay soil but need good drainage due to that it is intolerant of waterlogged conditions, Jatropha could grow and survive in marginal lands and poor quality water, but this reflected in low yield under these conditions [31].

Jatropha usage:

Jatropha curcas is a multipurpose shrub (Fig. 3), and it has more interest in arid and semiarid regions as biofuel plants [30], also, there are various usages for all parts as follow:

The main purpose for Jatropha in current decades is produce biofuel or biodiesel from seeds [10].

The press cake of jatropha seeds considered biomass feedstock to produce energy or biogas [32].

Press cake is reach in protein, it is used as organic fertilizers.

Powdered seed coat can be used as an adsorbent for exclusion of heavy metals from wastewater [33].

Jatropha trees are used as hedges because it is unpalatable to animals [23].

Jatropha curcas is used to stop soil erosion and as desertification plant [11].

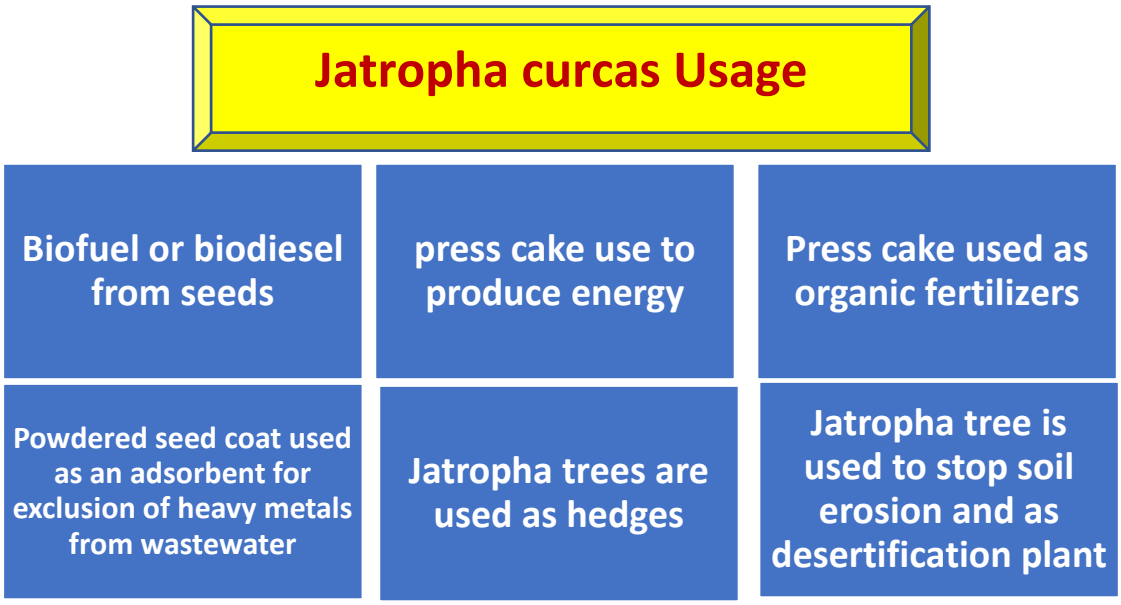

Fig. 3: Jatropha various usage

Conclusions

Jatropha curcas has more interest in last decades as a renewable biofuel source to reduce environmental pollution, also, it is used for desertification and decrease soil degradation in arid and semiarid regions, Jatropha could grow at altitudes up to 500 meters above sea level, therefore it is grow in various conditions, it is could tolerate drought for long time by shedding their leaves but cannot tolerate cold climate, moreover, it does not compete with food crops, Jatropha growing in marginal lands and it is survive and produce seed yield under lowest water quantity compared to other crops, also, jatropha grow well with sewage treated water. Jatropha curcas is a multipurpose plant and have different advantage like short gestation period, minimum water requirements, and being unpalatable to grazers, also, Jatropha curcas can reduce soil degradation and desertification in arid regions.

Conflicts of Interest

No conflicts exist.

Funding Statement

No funding for this work

References

1. Wurdack, K. J., Hoffmann, P. and Chase, M. W. (2005). Molecular phylogenetic analysis of uniovulate euphorbiaceae (*euphorbiaceae sensustricto*) using plastid RBCL and TRNL-F DNA sequences. Am. J. Bot. 92(8):1397-1420.
2. Pecina-Quintero, V., Anaya-López, J. L., Zamarripa-Colmenero, A. and Núñez-Colín, C.A., (2014). Genetic structure of Jatropha curcas L. in Mexico and probable centre of origin. Biomass Energ 60: 147-155 http://dx.doi.org/10.1016/j. biombioe.2013.11.005.
3. Azam, M. M., Waris, A. and Nahar, N.M. (2005). Prospects and potential of fatty acid methyl esters of some non-traditional seed oils for use as biodiesel in India. Biomass and Bioenergy, 29: 293-302
4. Gamal-Fakhry, Azazz, N. A. E., Abdel-Monem, A. and Mohamedin, A. (2016). Use of waste water and treated water for jatropha curcas cultivation and the possibility of oil seed use as a biofuel. Minia J. of Agric. Res. & Develop. Vol. 36(2):245-269.
5. Barceloux, D. G. (2008). Medical toxicology of natural substances foods, fungi, medicinal herbs, plants, and venomous Animals. John Wiley & Sons, Inc.: Hoboken, NJ, USA. 2008.
6. Godin, V. and Spensley, P. (1971). Oils and oilseeds. T J P Crop Product Digest 1971, 1:107–110.
7. Henning, R. K. b (2004).The jatropha system: An integrated approach of rural development." Working paper, Bagani GBR, Weissensberg, Germany, 2004.
8. Divakara, B.N., Upadhyaya, H.D., Wani, S.P. and Laxmipathi, G.C.L. (2010). Biology and genetic improvement of *Jatropha curcas L.*: a review. Appl Energy. 87(3): 732-742
9. King, A.J., Wei, H., Cuevas, J.A., Freudenberger, M., Ramiaramanana, D. and Graham, I.A. (2009). Potential of Jatropha curcas as a source of renewable oil and animal feed. Journal of Experimental Botany. (http://jxb.oxfordjournals.org).
10. AbouKheira, A. A. and Atta, N. M. M. (2009). Response of *Jatropha curcas* L. to water deficit: yield, water use efficiency and oilseed characteristics. Biomass and Bioenergy. 33 (10):1343–1350.
11. Francis, G., Edinger, R. and Becker, K. (2005). A concept for simultaneous wasteland reclamation, fuel production, and socioeconomic development in degraded areas in India: need, potential and perspectives of Jatropha plantations. Natural Resources Forum, 29(1): 12–24.

12. Swanberg, K. (2009). Economic Feasibility of Alternative Crops with Potential for the Reuse of Treated Waste water in Egypt. International Resources Group, Washington DC.

13. Riyadh, M. (2002). The cultivation of *Jatropha curcas* in Egypt. Undersecretary of State for Forestation, Ministry of Agriculture and Land Reclamation (leaflet).

14. Gudeta, T.B. (2016). Chemical composition, bio–diesel potential and uses of *Jatropha curcas L.* (Euphorbiaceae). American Journal of Agriculture and Forestry. 6(8): 35-48.

15. Dehgan B, Webster, G. L. (1979) Morphology and Intrageneric Relationships of the Genus Jatropha Euphorbiaceae). 74. University of California Publications in Botany.

16. Arruda, F.P., Macedo, B.N., Pereira, A.A., Pereira, W., Soares, S.L. (2004). Cultivo de pinhão-manso (*Jatropha curcas*) como alternative para o semiáridonordestino. Rev Bras OlFibros. 8(1): 789-799.

17. Makkar, H. P.S., Aderibigbe, A. O., and Becker, K. (1998). Comparative evaluation of non-toxic and toxic variety of *jatropha curcas* for chemical composition, digestibility, protein degradability and toxic factors. Food Chem. 62(2):207-15.

18. Kaushik, N. (2003). Effect of capsule maturity on germination and seedling vigour in *Jatropha curcas*. Seed Science and Technology. 31:449-454.

19. Anil Kumar, A., Patil, N.S., Kumar, R. and Mandal. D. (2017). Irrigation Scheduling and Fertilization Improves Production Potential of Jatropha *(Jatropha curcas L.*).Int. J. Curr. Microbiol. App. Sci 6(5): 1703-1716.

20. Soliman, W.M. and He, X.R. (2015).The Potentials of Jatropha Plantations in Egypt: A Review. Modern Economy, 6, 190-200. http://dx.doi.org/10.4236/me.2015.62016

21. Brittaine, R. and Lutaladio, NB. (2010). Jatropha: a small holder bioenergy crop. Integrated Crop Management Vol. 8:1-96.

22. Michael, A.M. (1978). Crop response to water at different stages of growth. Irrigation theory and practice, Vikas publishing house Pvt. Ltd. 560.

23. Corte-Real, N., Endres, L., Santos, K.P.O., Figueirêdo, R.C.B., Arruda, E.C.P. and Ulisses, C. (2016). Morphoanatomy and ontogeny of the fruit and seeds of *Jatropha curcas* L.: A promising biofuel plant. In: Segura-Campos MR, Betancur-Ancova D, editors. The Promising Future of *Jatropha curcas*: Proprieties and potential applications. Hauppauge, NY: Nova Science Publishers, Inc. p. 141-58.

24. Heller, J. (1996). Physic nut. *Jatropha curcas L*. Promoting the conservation and use of underutilized and neglected crops. Institute of Plant Genetics and Crop Plant Research (IPGRI), Gatersleben/International Plant Genetic Resources Institute, Rome, Italy, p. 66

25. Kaushik, N. and Kumar, S. (2004). *Jatropha curcas* L. Silviculture and Uses. Agrobios (India), Jodhpur

26. Achten, W. M. J., Maes, W. H., and Reubens, B. (2010). Biomass production and allocation in Jatropha curcas L. seedlings under different levels of drought stress. Biomass and Bioenergy, 34(5): 667–676.

27. Dasumiati, Miftahudin , Triadiati,T. and Hartana, A. (2017). Sex types in flowering of *Jatropha curcas*. Biodiversitas 18(1):442-446.

28. Maes, W. H., Achten, W. M. J., Reubens, B., Raes, D., Samson, R. and Muys, B. (2009). Plant-water relationships and growth strategies of *Jatropha curcas L*. seedlings under different levels of drought stress. Journal of Arid Environments. 73(10): 877– 884.

29. Genhua, N., Rodriguez, D., Mendoza, M., Jifon, J. and Ganjegunte, G.(2012). Responses of *Jatropha curcas* to Salt and Drought Stresses. International Journal of Agronomy Volume 2012, Article ID 632026, 7 pages.

30. Gour, V. K. (2006). Production Practices Including PostHarvest Management of Jatropha curcas. In Proc. of the Biodiesel Conference Toward Energy Independence – Focus on Jatropha, edited by B. Singh, R. Swaminathan, and V. Ponraj, 223–251. New Delhi, India: RashtrapatiBhawan.

31. Santos, M. R. P. and Silva, M. J. M. (2016). Growth and development of *Jatropha curcas* seedlings using Terracotem soil conditioners under different irrigation levels. Emirates Journal of Food and Agriculture. 28(5): 326-331.

32. Augustus, G. D., Jayubalan, M. and Seiler, G.J. (2002). Evaluation and bioinduction of energy components of *Jatropha curcas*. Biomass Bioenergy. 23: 161 - 164.

33. Hsu, S., Huang, C., Chung, T. W. and Gao, S. (2014) Adsorption of chlorinated volatile organic compounds using activated carbon made from Jatropha curcas seeds. Journal of the Taiwan Institute of Chemical Engineers, Vol. 45, Issue 5, 2526 - 2530.