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BIOMASS & BIOENERGY

Above-ground morphological predictors of rooting success in rooted cuttings of *Jatropha curcas* L.

Dinesh Kumar, Sanjay Singh, Ritesh Sharma [1], Vishavjit Kumar [2], Harish Chandra, Kshitij Malhotra*

Silviculture Division, Forest Research Institute, New Forest, Dehradun, Uttarakhand 248006, India

ARTICLE INFO

Article history:
Received 16 February 2010
Received in revised form
30 May 2011
Accepted 2 June 2011
Available online 5 July 2011

Keywords:
Sprout length
Rooting
Root length
Vegetative propagation
Jatropha curcas
Predictor

ABSTRACT

Cuttings of 1–3 cm diameter and 45 cm length were collected during the first week of February from branches of previous year's growth in a mature plantation of *Jatropha curcas*. The cuttings, without application of any growth regulator, were planted in nursery beds having loam: gravel (1:1 v/v) mixture rooting media. The nursery beds existed inside a polyethylene tunnel where intermittent misting was done. When sprouting percentage had stabilised, sprouted cuttings were removed from the media, and root and shoot characteristics of the cuttings were recorded. The number of roots and root length were found to be significantly correlated ($P < 0.01$) with one another as well as with sprout length, number of sprouts and number of leaves. The following equations were fitted for prediction of root characteristics of a cutting from of its above-ground characteristics: (i) No. of roots = −0.409 + 0.452 (no. of leaves) + 0.395 (sprout length), and (ii) Root length = 2.656 + 0.206 (no. of leaves) + 0.270 (sprout length); the sprout length and root length are in centimetres in both equations. Thicker cuttings possessed better root and above-ground characteristics.

1. Introduction

Jatropha curcas L. is a wild exotic shrub or small tree that belongs to family Euphorbiaceae. It is a tropical plant that can be grown in low to high rainfall areas and can be used to reclaim land, besides being planted as a commercial crop. Growing it could provide employment, improve the environment and enhance the quality of rural life [1]. It is perceived to be a potential species for reducing dependence of India on imports of conventional petroleum-based fuels. The oil extracted from the seeds of this species can be used as a substitute for diesel. The government of India has ambitious biofuel policy which envisages cultivation of this species on a massive scale in India. The Planning Commission has plans to bring 2.19 million ha land under plantations of this species by 2006–07 and 11.19 million ha by 2011–12 [2]. Several public and private sector companies have also joined in this effort. Efforts are underway in various institutions to produce high-yielding genotypes for increasing production per unit area. The species is raised in nurseries through seeds as well as cuttings. However, the required quantity of genetically pure seed for commercial plantings is not available. A lot of genetic variation exists in the seed material of this species [3], which necessitates vegetative propagation of superior germplasm.

* *Corresponding author*. Tel.: +91 135 222 4601; fax: +91 135 275 6865.
E-mail addresses: kumard@icfre.org (D. Kumar), ritesh.forester@gmail.com (R. Sharma).
[1] Present address: Pastureland Management, PMU, IGWDP, NABARD, 97, Navratna Complex, Bedla Road, Fatehpura, Udaipur, Rajasthan 313001, India.
[2] Present address: Rain Forest Research Institute, A.T. Road (East), P.O. Box 136, Jorhat, Assam 785001, India.
0961-9534/$ – see front matter
doi:10.1016/j.biombioe.2011.06.019

Plants raised through vegetative propagation are true to type, reduce juvenile phase and lead to early flowering and fruiting in several tree and shrub species [4], including *J. curcas* [5–8]. Cloning maintains genetic purity and uniformity and allows gainful exploitation of useful variation, besides contributing to meet the huge demand for high-quality planting material at commercial scale [9]. Clonal approach can be employed to raise plantations of *J. curcas* to provide early returns to the growers [5,10,11]. Huge variation in seed yield, ranging from 50 g $tree^{-1}$ to 4 kg $tree^{-1}$ has been noticed by the authors during their field surveys in north India. Variation in oil content ranged from 23.08% to 40.17% during these surveys; fatty acid composition was also variable among different genotypes (authors' unpublished data). A part of these variations can be attributable to genetic factors, which can be effectively captured and utilised through cloning. Vegetative propagation is, therefore, likely to play a significant role in future plantation programmes of *J. curcas*. Department of Biotechnology, New Delhi has operational guidelines to establish about half of the plantations of this species through vegetative means.

In vegetative propagation through branch cuttings, the cuttings of *J. curcas* are inserted in the rooting media under humid environmental conditions. Sprouting of buds on the cuttings begins and root initiation takes place. New leaves emerge while root development continues. Cuttings vary in their speed of root development due to variation in cutting thickness, position of cutting on mother plant, age of mother plant, etc. [3,4,12,13]. The rooted cuttings are removed from the rooting media and transplanted into containers (usually polyethylene bags) in the nursery for further growth and development. The space vacated by rooted cuttings is filled up by fresh lot of cuttings. Plant propagators are under continuous pressure to remove rooted cuttings as early as possible, so as to root maximum feasible number of cuttings per unit area per unit time. To judge the suitability of cuttings for transplanting, the cuttings are required to be removed frequently from the rooting media and examined for status of rooting. The duration of time spent by cuttings in the propagation area cannot be a dependable guide to judge the rooting success because speed of root development may vary with season [14,15], besides other factors. Removal of cuttings, even temporarily, with under-developed roots may impair root development or damage the roots. The task of judging rooting status of cuttings becomes all the more cumbersome when cuttings in a bed do not grow uniformly for having been collected from diverse sources, as often occurs during initial stages of genetic improvement programmes. Shortage of cuttings is a major handicap in large scale clonal planting of this species [10]. Due to scarcity of cuttings, the propagators tend to collect cuttings from all possible sources, thereby planting a mixture of cuttings with variable rooting behaviour.

Under the ongoing genetic improvement programme of this species at Forest Research Institute, Dehradun where rooted material was to be exchanged with collaborating organisations, need was felt to develop some easy-to-observe above-ground morphological indicators that may help in deciding whether or not a cutting has developed roots sufficiently so as to be ready for being removed from the rooting media. Period of time for which cuttings have been kept for rooting cannot be considered to be a reliable indicator of rooting status as environmental conditions may vary from place to place and season to season. Hence a study was carried out to develop some above-ground morphological indicators of rooting success. The findings of the same are reported in this paper.

2. Material and methods

The study was carried out in Central Nursery, Forest Research Institute, Dehradun located at 30°19′N latitude and 78°03′E longitude. One-year-old, healthy and straight branches were collected from mature plants (6–8 years old) of *J. curcas* at Allahabad in Uttar Pradesh during the first week of March. The branches were cut into pieces of 1.10 m length, packed in gunny bags and transported to Dehradun in ambient temperature and humidity conditions. Two thousand four hundred hardwood cuttings of 45 cm length and 1–3 cm thickness (measured at mid-point along length of the cutting) were made. The cuttings were vertically planted in nursery bed having loam and fine gravel (2.0–4.0 mm size) in 1:1 (v/v) ratio. Correct polarity was maintained during transportation as well as planting of the plant material. The nursery bed where cuttings were raised, was surrounded by 1.25 m high, UV-stabilised, transparent, colourless polyethylene sheet on all sides and misting was done with fine nozzle to keep humidity in range of 75–90% and absolute maximum temperature between 35 °C and 39 °C. Irrigation was done once daily. Sprouting percentage of the cuttings was recorded weekly. Spouting started in the second week of April. Sprouting was variable and some of the cuttings could sprout as late as first week of May. In second week of May, there was no significant weekly increment in sprouting percentage of cuttings, hence the cuttings were safely removed from the nursery beds. Sprouting percentage was 68.4% at that stage. Data were recorded about cutting thickness, number of sprouted shoots, number of leaves, sprout length, number of roots (roots exceeding 2 cm length) and root length for randomly selected sprouted cuttings. Sprout length and root length were defined as the length of main sprouted shoot and the length of main lateral root, respectively.

Pearson correlation coefficient (r) was computed for all parameter combinations. Step-wise multiple regression analysis was carried out with SPSS software version 11.0 using number of roots and root length as dependent variables and number of sprouts, number of leaves and sprout length as independent variables.

3. Results

The results of the Pearson correlation analysis (Table 1) indicate that all parameter combinations, except number of sprouts with sprout length, are significantly correlated with one another (d.f. = 52). Furthermore, all significant correlations proved their significance at 0.01 level, except the correlation between number of leaves and sprout length which was significant at 0.05 level. Thus all of the above-ground parameters under observation are strongly correlated with rooting characteristics. Maximum correlation (0.794) was observed