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Research Paper

VEGETATIVE PROPAGATION OF *Caesalpinia ferrea* Mart. ex. Tul. var. ferrea

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Abstract

Caesalpinia ferrea Mart. ex Tul. var. ferrea is a tree of northeastern Brazil and has use medicinal, timber, ornamental and forage. The seeds have dormancy which hinders the production of seedlings. The aim of this work was to evaluate the rooting of cuttings from aereal part and rhizome of *C. ferrea* in 12 experiments at different times to collect cuttings, cuttings types, substrates and use of indole butyric acid (IBA). The percentage of rooting of cuttings from aereal part was less than 30% even with the use of IBA. At 50 days after planting was found 85% of rooting of cuttings from rhizome treated with 6000 mg L^{-1} IBA. The lowest average rooting (40%), number of roots (1.8) and root length (3.2 cm) occurred in cuttings without IBA, highlighting the importance of using rooting hormone. Propagation by cutting from aereal part of *C. ferrea* is not feasible. *C. ferrea* can be propagated by cuttings extracted from rooting system of plants with 16 months of age, with 18cm long and treated with 6000 mg L^{-1} of IBA.

Key words: *Caesalpinia ferrea*; root cuttings; IBA; seedling production.

INTRODUCTION

Caesalpinia ferrea Mart. ex. Tul. var. ferrea is a tree of the caatinga Northeast of Brazil and is used how medicinal, timber, ornamental and forage [1]. The bark and pods of *C. ferrea* are used in folk medicine for the treatment of broncho-pulmonary diseases, diabetes, rheumatism, cancer, gastrointestinal disorders, diarrhea, inflammation and pain [2]. The tree is recommended for afforestation of squares, parks, roads and parking lots [3].

Pharmacological studies showed that *C. ferrea* has properties antifungal and antibacterial, anti-ulcer, anti-inflammatory, analgesic [4] and larvicide against *Aedes aegypti* [5]. In the state of Rio Grande do Norte, the bark powder of *C. ferrea* is widely used by the population for the treatment of skin wounds [6].

Rising demand and intense extraction have contributed to the reduction in the number of plants in the areas of natural occurrence. Thus, populations of *C. ferrea* has danger of drastic decline, in the medium term, caused for the lack of establishment of new plants [1], possibly due to seed dormancy [7] or grazing by animals [8].

The propagation by seeds *C. ferrea* has been hampered by seedcoat impermeable to water ingress [7, 9] and slow germination and uniformity, which makes the production of seedlings difficult [8]. In commercial production of seedlings, the vegetative propagation is sometimes more important than the sexual propagation, because is faster than propagation by seed, the unproductive period is shorter due to the reduction of the juvenile stage whose duration is two or more years [10]. Besides enabling a greater uniformity of plants and allow the production of plants identical to the mother plant, which is important in the preservation of desirable agronomic traits [11].

The formation of adventitious roots in cuttings is increased with immersion in auxin solutions [12]. Among the auxins used to assist the rooting, the indole butyric acid (IBA) is very efficient because its action somewhat toxic in most plants, even at high concentrations, and it is photostable and less susceptible to the degradation [12]. Several studies have evaluated the effect of IBA on rooting of cuttings of tree species [13,14], but there are few studies that address the use this auxin in the treatment of root cuttings.

The aim of this study was to evaluate the potential of sprouting and rooting of cuttings of shoot and root of *C. ferrea* types of cuttings, substrates and use of IBA.

MATERIALS AND METHODS

The study was conducted in the greenhouse (50% shading obtained mesh polyolefin type "sombrite") in the Universidade Federal Rural do Semi Árido, Mossoró, Rio Grande do Norte, located in the geographic coordinates 5°11'31"S and 37º20'40"W, with an average altitude of 18 m. The climate in Köeppen classification, is the type Bswh '(hot and dry), with very irregular rainfall, annual average of 673.9 mm, temperature 27 °C and relative humidity average of 68,9% [15].

Twelve experiments were conducted using cuttings of *C. ferrea* obtained at different times of the year. The cuttings were immersed for 5 minutes in a solution of sodium hypochlorite at 0.6% for disinfection, then washed in water. The cuttings were introduced to two thirds of its length and then the substrates involved in polyethylene bags in order to prevent against dehydration. There were two daily irrigation in the dry season, and one every two days in the rainy season.

Were performed data analyzes using the computer program SISVAR [16], resulting in analysis of variance and mean test (Tukey at 5% probability) and the comparison of IBA, by analysis of variance of the regression.

Experiment 1

The experiment was installed on August 21, 2010 during the dry season, and cuttings of aereal part with 2 cm long and 1.0 cm diameter, collected from adult trees. The experimental design was completely randomized with six treatments and four replications with ten cuttings. The treatments were the following concentrations of indole butyric acid (IBA) 0, 1000, 2000, 3000, 4000 and 5000 mg L^{-1} IBA. We used polypropylene trays of 50 cells with a volume of 90 mm^3 were filled with carbonized rice husk.

Experiment 2

The experiment was installed on September 21, 2010, during the dry season, with semi woody cuttings 12 cm in length and diameter from 0.6 to 1.0 cm. Cuttings of aereal part were collected from adult trees of *C. ferrea* who had experienced a severe pruning at 60 days to provide the semi woody shoots. The experimental design was completely randomized with five treatments and four replications with ten cuttings. The treatments were the following concentrations of indole butyric acid (IBA): 0, 1000, 2000, 3000, 4000 mg L^{-1} IBA. We used polypropylene trays of 50 cells with a volume of 90mm^3 were filled with rice husk carbonized cattle manure (3:1 v/v).

Experiment 3

The experiment was installed on October 27, 2010, in the dry season. Semi woody cuttings obtained with 13 cm long and 0.8 to 1.2 cm in diameter were collected on adult trees of *C. ferrea* who had experienced a severe pruning at 90 days to provide the semi woody cuttings of aereal part. The experimental design was completely randomized with five treatments and four replications with ten cuttings. The treatments were the following concentrations of indole butyric acid (IBA): 0, 2000, 4000, 6000 and 8000 mg

L^{-1} IBA. We used polypropylene trays of 50 cells with a volume of 90 mm^3 were filled with rice husk carbonized cattle manure (3:1 v/v).

Experiment 4

The experiment was installed on December 3, 2010, in the dry season, with softwood cuttings from aereal part with 18 cm long and 1 cm in diameter, collected from adult trees of *C. ferrea* who had experienced a severe pruning at 120 days in order to provide the semi wood shoots. The experimental design was completely randomized with four treatments (rice husk carbonized, sand, coconut fibre and soil of the natural range of the species) with five replicates of 10 cuttings in each plot. Polypropylene trays were used with 50 cells with volume 90mm^3.

Experiment 5

The experiment was installed on March 29, 2011, during the rainy season. Cuttings with 18 cm long and diameter 0.9 to 2.2 cm were collected from adult trees of *C. ferrea* who had experienced a severe pruning at 60 days to provide the semi woody shoots. The cuttings were placed in substrate rice husk carbonized. The experimental design was completely randomized with five treatments (0, 2000, 4000, 6000 and 8000 mg L^{-1} IBA) and four replicates of ten cuttings.

Experiment 6

The experiment was installed on March 21, 2011 in the rainy season. Cuttings with 18 cm long and 1.0 cm in average diameter were used. The experimental design was completely randomized with five treatments (sand, rice husk carbonized, coconut fiber, vermiculite and soil) with five replicates.

Experiment 7

The experiment was installed on October 30, 2010 during the dry season. Cuttings with two leaf measuring 10 cm in length and diameter 0,3 to 0,4 cm were used. The experimental design was completely randomized with four treatments (rice hulls, coconut fiber, vermiculite and solo manure (3:1 v/v) with four replications of ten cuttings.

Experiment 8

The experiment was installed on April 16, 2011 in the rainy season. Cuttings with two leaf, measuring 12 cm in length and diameter 0.25 to 0.4 cm were used. The experimental design was completely randomized with five treatments (0, 1000, 2000, 3000 and 4000 mg L^{-1} IBA), with four replicates of ten cuttings.

Experiment 9

The experiment was installed on August 21, 2010, dry season. Were used softwood cuttings measuring 12 cm long and 1.0 cm diameter, of seedlings of *C. ferrea* with 14 months of age and obtained by means of seeds. The experimental design was completely randomized with five treatments (0, 1000, 2000, 3000 and 4000 mg L^{-1} IBA), with four replicates of ten cuttings.

Experiment 10

The experiment was installed on March 20, 2011, in the rainy season. Were used softwood cuttings measuring 18 cm in length and diameter around 1.0 cm, of seedlings of *C. ferrea* with six months old. The treatments were 0, 2000, 4000, 6000 and 8000 mg L^{-1} IBA arranged in a completely randomized design with four replications of ten cuttings.

Experiment 11

The experiment was installed on October 29, 2010 in the dry season. Root cuttings were used, measuring 11 cm in length and diameter 0.6 to 1.5 cm, obtained from seedlings *C. ferrea* with 16 months old. The experimental design was completely randomized with four treatments and five replicates of 10 cuttings. The treatments were the substrates, rice hulls, vermiculite, coconut fiber and soil + and manure mixture (3:1 v/v).

Experiment 12

The experiment was installed on October 29, 2010, in the dry season. Root cuttings were used, measuring 18 cm in length and diameter from 0.8 to 1.2 cm, obtained from seedlings *C. ferrea* with 16 months old. The treatments were 0, 2000, 4000, 6000 and 8000 mg L^{-1} IBA, with four replicates of five cuttings.

RESULTS AND DISCUSSION

The hardwood cuttings of *C. ferrea* collected in the dry season (experiment 1) not rooted and had only 17% of shoots. The semihardwood cuttings, taken from aereal part in the dry season, and collected during the rainy season (experiments 2 a 6), also not rooted and showed only 15-30% of shoots regardless of the treatments and the time to collect cuttings. In cuttings that were submitted to substrates composed of organic residue showed the presence of pathogens.

The cuttings (experiments 7 and 8) have not sprouted nor rooted after 60 days, regardless of the time to collect cuttings. For softwood cuttings taken from seedlings *C. ferrea* with 14 months of age (experiment 9), was found at 60 days, the presence of 18% for shoots and three rooted cuttings: one for the treatment of 3000 and 4000 mg in two L^{-1} IBA. However, best results were achieved with softwood cuttings taken from seedlings of *C. ferrea* at 6 months of age, in the rainy season (experiment 10), showed that, after 45 days in the rooting beds, an average of 17% rooting among the treatments, with the highest percentage, 30%, for the cuttings that were not treated with IBA, although there were no significant differences among treatments. Factors such as the age of the seedlings of which were taken *C. ferrea* cuttings (16 months), length (18 cm) and the diameter of the piles (0.8 to 1.2 cm), may have contributed positively rooting. These results point to the prospect of working with cuttings taken from young material preferably of clonal.

Stem cuttings from *C. ferrea* in different situations such as collection times, cutting type, substrate and use of IBA showed poor rooting, which puts this species in the category of those difficult propagation by cuttings. The disadvantages of rooting include the difficulty of inducing the production of adventitious roots in many species [17]. In a study of species of the same genus, *Caesalpinia echinata*, [18] found that concentrations of indole butyric acid (IBA) and naphthalene acetic acid (NAA) of 0, 1250, 2500, 5000, 10000 mg L^{-1} had no effect on survival and callus formation in cuttings, and cuttings treated with 2.500 mg L^{-1} both showed high auxin rooting higher than the control, but still low (16%) and concluded that the residence time of the cuttings in greenhouse must be more than 120 days since a large part of the cutting survivors had no roots or calluses.

In experiment 11, 45 days after planting 65% of the cuttings rooted in vermiculite, but no significant difference among treatments for any of the traits. In experiment 12, the dose of 6000 mg L^{-1} IBA significant effect on rooting (85%) at 50 days after planting. The lowest average rooting (40%), number of roots (1.8) and root length (3.2 cm) occurred in the stakes that was not applied plant regulator, highlighting the importance of the use of induced rooting. The quadratic model was adequate to explain the survival of the cuttings root number, longest root length, root dry biomass and percentage of cuttings with roots that reached a maximum concentration of 6000 mg L^{-1} IBA (Figure 1).

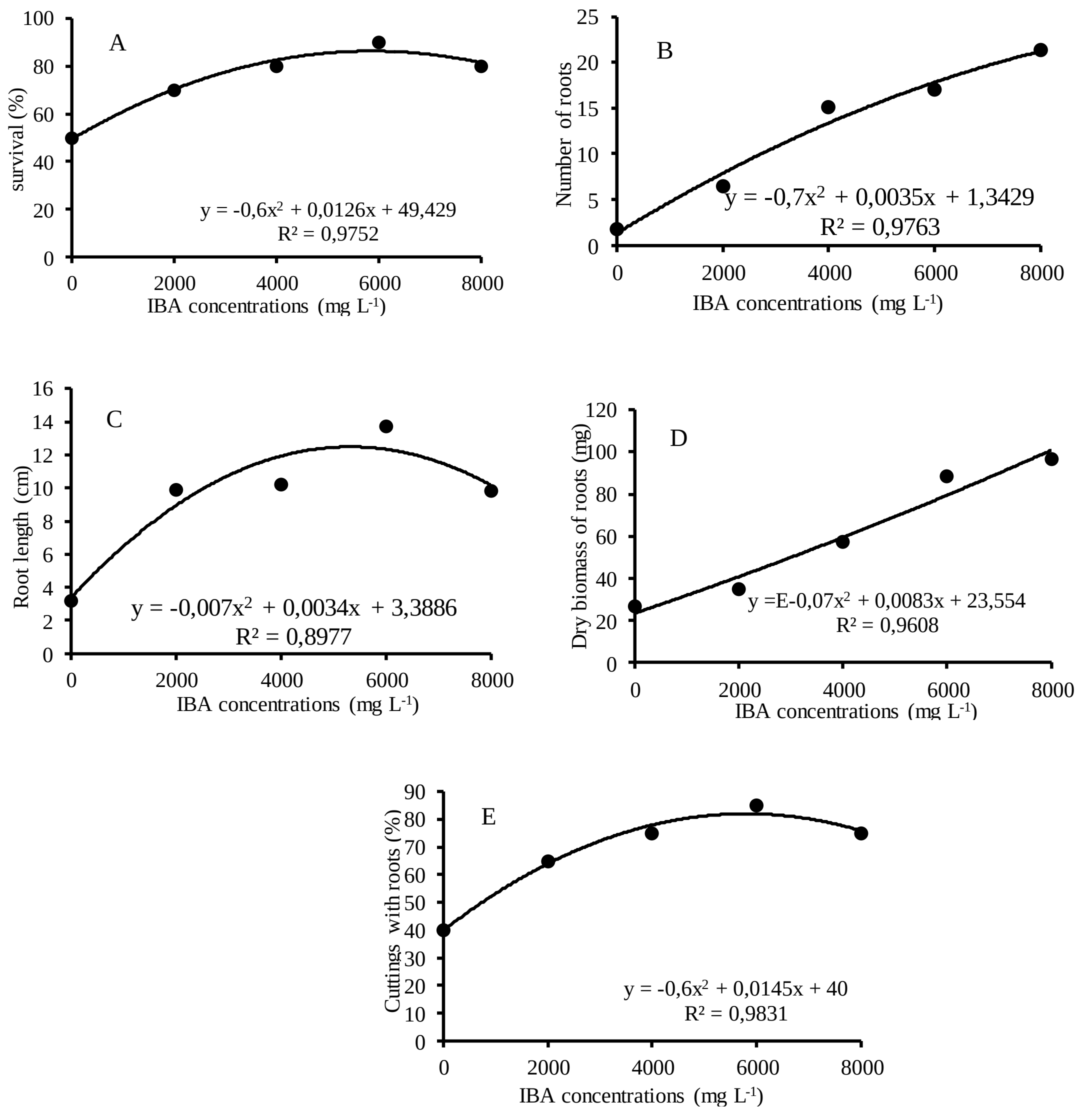

Figure 1: Survival percentage (A), number of roots (B), root length (C), root biomass (D) and percentage of cuttings rooted (E) taken from seedlings originating from roots of *Caesalpinia ferrea* in different concentrations of IBA. Mossoró, Rio Grande do Norte, Brazil, 2010.

The number of roots per cutting (Figure 1 B) and dry biomass of roots (Figure 1D) did not reach maximum values at the concentrations used, indicating that can still be evaluated IBA concentrations exceeding 8000 mg L^{-1}. The percentage of sprouted cuttings and shoot biomass reached maximum value at the concentration of 2.000 mg L^{-1} of IBA (Figure 2).

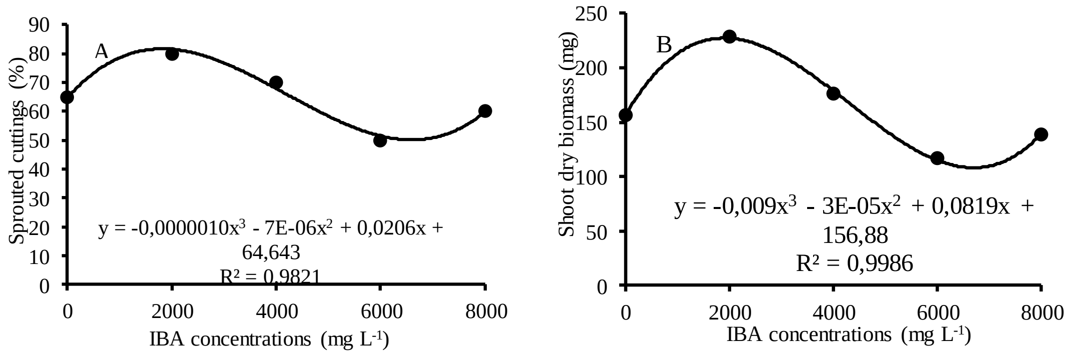

Figure 2: Sprouting cuttings (A), shoot dry biomass (B) taken from seedlings originating from roots of *Caesalpinia ferrea* in different concentrations of IBA. Mossoró, Rio Grande do Norte, Brazil, 2010.

These results show that plants that have difficulty in rooting cuttings of shoots, can be propagated from cuttings derived from roots. Although cuttings roots show no vegetative buds was observed in *C. ferrea* good average shoots, demonstrating totipotentiality (ability of a single cell give an individual multicellular) resulting in a balance between shoots (average 65% of sprouted cuttings) and root system (average of 68% rooting).

The favorable results obtained with rooting *C. ferrea* root when using the induction of adventitious roots with IBA can be explained by the action of auxin in establishing jurisdiction and determination of target cells [19], which have caused rhizogenic responses which increased as the IBA (Figure 1B). Thus, the highest rooting of root cuttings treated with IBA *C. ferrea* may be related to the relative high auxin/cytokinin.

Several studies have evaluated the effect of IBA on rooting of cuttings of tree species [14, 20], but there are few studies that address the use of this auxin in the treatment of root cuttings. Rooting and budding occurs from root cuttings of *Artocarpus altilis* (Parkinson) Fosberg var. Apyrena without the need to apply AIB [21], while the raspberry (*Rubus* sp.) can be efficiently propagated by cuttings root but not used inductors [22].

The formation of guava plants by cuttings root is obtained easily and always results in a high percentage of fruit set, are chosen as those with 0.7 to 1.2 cm in diameter and 15-22 cm long [23]. Cuttings root of *Brosimum gaudichaudii* Trec. had the highest rates of rooting (51.3%) in the treatment that was administered the highest dose of IBA (1000 mg L^{-1}) [15]. The use of IBA favored rooting of *Cordia trichoma* with higher responses in treatments with doses of 3000 mg L^{-1} larger diameter root cuttings were more suitable for shooting when compared to the thinner root cuttings [24]

The best results with cuttings roots are affected if they are taken from young plants in late winter or early spring, when the roots are well supplied with nutrients stored, and before starting a new plant growth [12]. The withdrawal of the pile should be avoided in the spring, when the plant is developing. It is important to recognize that these conditions correspond to the rest period of the plant, which in northeast Brazil corresponds to the dry season (June to December).

The use of clonal to provide cuttings for propagation has been effective in some species [25, 26]. Often the matrix material suppliers are unfavorable phenological stages in the formation of roots as, for example, in flowering and/or fruit [26]. The deployment of clonal aiming to provide propagation material becomes advantageous because, besides allowing the collection of branches throughout the year may have juvenile character and vigor, these characteristics favorable to rooting.

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