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Kinetical Germination Study of the *Chamaerops humilis* L. var. *argentea* Andre (Arecaceae)

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Abstract: *Chamaerops humilis*, fairly common species in the Western Mediterranean, fell under the human impact in the region of Tlemcen (West Algeria). This study aims to highlight the characteristics of regeneration by planting *Chamaerops humilis* L. var. *argentea* Andre. The laboratory experiments tell us about the latency and germination capacity. This is equal to 58% in the experimental conditions. The post-germination survey shows 3 parts: Cotyledonary Cord (CC), Cotyledonary Ocrea (CO) and Radicle (R), different in shape and in length. The growth kinetics is based on morphometric measures of the early stages of developing post germination, enables the elongation speeds of the 1st components to know growth of this taxon. The cumulative growth of 3 parts ranges between 0.232 and 0.165 cm day^{-1}, an average of 0.204 cm day^{-1}.

Key words: *Chamaerops humilis* L. var. *argentea* Andre, latency time, germination capacity, growth kinetics, speed, elongation

INTRODUCTION

Chamaerops humilis L. var. *argentea* is a monocotyledon belonging to the Arecaceae family that counts 2500 species of which >800 are cultivated (Ellison and Ellison, 2001). This species, endemic of the western Mediterranean basin (Negre, 1951; Cuenod, 1954; Maire, 1957), is very little represented on the northern shore because of its thermophile character. In the mounts of Tlemcen (western Algeria) it lies on an important altitude section. It is found from the coastline up to >1616 m in Djebel Dar Echikh (Hasnaoui, 1998). At present, its area of distribution is regressing in some parts of Western Algeria because the overgrazing, grubbing, urbanization and fires. In France, it seems to have disappeared of the natural habitat of the region of Nice in 1866 (Fournier, 1951). However, some individuals have just been, observed on the Provencal coastline, mainly close to this locality (Medail and Quezel, 1996). *Chamaerops humilis* L., especially, represented by the variety *argentea* Andre in the region of Tlemcen, is a leading taxon that forms the physiognomy of many matorrals and pre forests of the west Algeria. Considered as a species of degradation of the forest formations (Dahmani, 1996), it plays an important role in the relict ecosystems, because of its reduced water requirements and generally of its adaptation to the ecological and anthropical constraints. In order to deepen the knowledge about this species and to bring some elements to the solutions that are likely to contribute to its regeneration by seedling, we undertook some experiments in the laboratory, about the seeds germination power of the argentea variety. Eighty three percent of the palms grow spontaneously (Jonhson, 1991) and little is known about the requirements of their germination and their growth. The germination of some palms is often irregular (Ellis *et al*., 1985). Ishihata (1974), Murakami and Rauch (1983), Gonzalez-Benito *et al*. (2006) and Hasnaoui (2008) showed the influence of temperature on the germination of *Chamaerops humilis* L.

It should be noted, that the information about all aspects of the technology of palm seeds (storage and germination) are inadequate (Dickie *et al*., 1992; Jonhson, 1996).

Knowing the germination Capacity (CG), time of Germination (DG) and the growth kinetics of this species are important for of its protection.

MATERIALS AND METHODS

Choice of the seeds: The seeds used in our tests have been harvested in November 2003 close to Ain Fezza (East of Tlemcen). At the moment of picking the fruits, the brown red color attests a morphological and physiological

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maturity of the seeds. Generally, the ripe seeds give a high rate of germination; there are some exceptions where the maturity of the seeds is of little importance (Broschat and Donselman, 1986). To increase the percentage of germination some parameters must be considered such as: state and viability of the seeds.

State of the seeds: Most palms seeds harvested on the soil are either infested or moldy (Rauch, 1995). To avoid seeds of bad qualities, we have picked the seeds directly from the raceme of the fruits.

Viability of the seeds: This parameter can be evaluated by the floating test. The seeds were placed in water for 24 h, we could, then, see that some seeds were affected and thus, we only considered those that were intact.

Treatment of the seeds: We removed the shells of the chosen seeds beforehand, then disinfected with sodium hypochlorite (1%), rinsed with water and soaked in water for 24 h at an ambient temperature of 20°C. The fibrous and fleshy pericarp can be at the origin of the fungicides that delay germination. To weaken the pericarp several days or weeks are necessary (Meerow, 1990; Marcus and Banks, 1999). We consider that this pre-soaking improves the absorption of water and eliminates the inhibitors of germination (Heller *et al*., 1990).

Sowing: The seeds are arranged in Petri dish (diameter = 9 cm), garnished with 2 layers of filter paper moistened by 5 cm^3 of distilled water. The tests were about 100 seeds distributed in 5 parts (20 seeds) placed in a steam room maintained in 25°C. The follow-up lasted 2 months. The optimal temperature of germination of the *Chamaerops humilis* L. varies between 20 and 30°C (Ishihata, 1974). The retained parameters to evaluate the performances of the germination kinetics were:

- Capacity of Germination (CG %)
- Time of Germination (DG, days)
- Kinetics of the growth of the cotyledonary elements and radicle

The 1st phases concerning the growth of the cotyledonary elements and the radicle were studied, that is why, the germinated seeds were placed in pots (depth = 20 cm and diameter = 10 cm). Sawdust was used, which permitted to uproot the plantations without damaging them. The discount in place, after measures, made itself easily, without deteriorating the plant material. A periodic follow-up and morphometric measures were achieved during 2 months after germination on a random sample of 20 individuals.

RESULTS AND DISCUSSION

Germination analysis: The small and cylindrical embryo of the *Chamaerops humilis* L. var. *argentea,* situated close to the placenta, bathes in an endosperm; the whole is surrounded by a hard endocarp. The germination of a seed depends on the conditions in which it is placed and of the vital characteristics of used seeds (Mazliack, 1982). In the present study, the temperature remained steady and the humification of the Petri dish was maintained constant. The observations were achieved every 2 days. The *Chamaerops humilis* presents a germination of distant embryo type. The observation of the coming out of the cotyledonary cord (about 1 mm) has been considered as a criteria of end of the physiological germination. As for the other Coryphoideae, the coming out of the cord is preceded by the opening of an opercule, situated at *Chamaerops humilis* L. at the level of the least rounded part of the seed, close to the placentation (Fig. 1). The obtained results show that the Germination time (DG) of the *Chamaerops humilis* L. var. *argentea* seeds proves to be long enough. Between the seedling and the apparition of the 1st element took 36 days from the cotyledonary cord. This period is probably due to the impermeability of the envelopes to water that hinders the imbibition of the embryo. The 24 h pre soaking, which was undertaken for the used set of seeds proves not to have weakened the coats of the seeds that remained dry and resistant to the bruising.

Soaking reduces the average time needed until the germination. However, pits or seeds which were soaked too long in water could reduce germination by lack of oxygen. The temperature of the soaking does not seem to have a significant effect on reaction (Tietema *et al*., 1992).

In the experimental conditions, we noted a display of the germination of the seeds of *Chamaerops humilis* L.

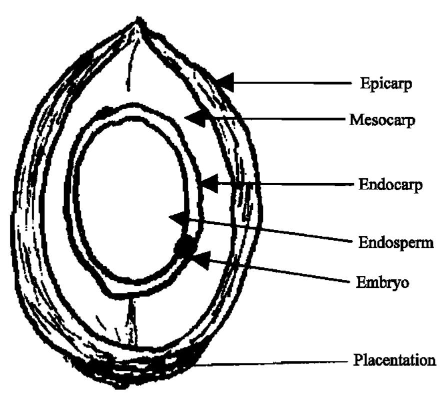

Fig. 1: Longitudinal section trough of the *Chamaerops humilis* L. var. *argentea*

Table 1: Germination capacity of *Chamaerops humilis* L. var. *argentea*

Time (days%)	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64
Germination	1	7	9	12	7	4	6	3	2	3	1	2	1	0	0
Germination accumulated	1	8	17	29	36	40	46	49	51	54	55	57	58	58	58

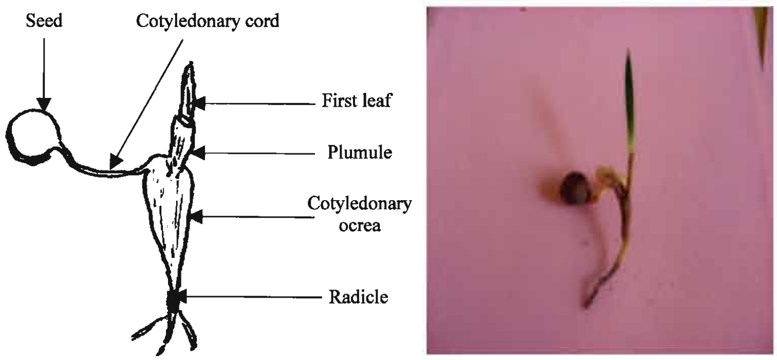

Fig. 2: Remote germination of the *Chamaerops humilis* L. var. *argentea*

var. *argentea* on 25 days with a maximal percentage of germination on the 42nd day; the accumulated percentage of germination (CG) is equal to 58% (Table 1). However, according to the recent research undertaken by Gonzalez-Benito *et al*. (2006) showed that the *Chamaerops humilis* germination percentage can change when using chemical treatment. They showed the temperature affect on germination.

In the natural conditions, the teguments impermeability entails a very spread germination and permits a long survival in the dehydrated state: the favorable characteristics to the local maintenance of the species. According to De Leon (1958) and Hong *et al*. (1996), the seeds of *Chamaerops humilis* L. keep their germination capacity a long time. The response of the seeds is maximal in the beginning, toward the 42nd day then it decreases and finally disappears after 60 days.

The growth kinetic of the cotyledonary elements and the radicle: The palms present 2 types of germination: remote germination, in which the axis of the young seedling develops itself to a certain distance of the real seed and the adjacent germination in which a button emerges out of the seed and will give radicle and leaves. The *Chamaerops humilis* L. var. *argentea* presents a remote germination (Fig. 2). As for the other palms of distant embryo, the observation of the germination morphology, with bare eye and with binocular microscope, allows to were distinguish 3 successive parts of different length and structures. The median parts of ovoid shape present a superior diameter to the other parts, it is the Cotyledonary Ocrea (CO) whose proximal part is larger than the distal part and which will give birth to the plumule. This part is joined to the seed by the Cotyledonary Cord (CC) that disappears with the apparition of first leaves and the weariness of the reserves of the seed.

Finally, the distal extremity is constituted by the Radicle (R) that will give birth to adventitious roots at the origin. The measures of the cotyledonary elements concern the length of the 3 parts at different moments. The kinetic follow-up of the cotyledonary elements and the radicle elongation which was undertaken every 10 days during 60 days, shows that the straight line of regression established in a random way for each of the 20 chosen samples, after linear adjustment are very close (Table 2 and Fig. 3). The slopes of the straight line are comprised between 1.04 and 3.93 and the coefficients of regression are all superior or equal to 97. Globally, the relation is meaningful, it is the shape:

$$E = aT - r$$

where:

E = The elongation
T = The time
r = Coefficient of regression

The obtained straight line shows homogeneity of the germination elements growth of the *Chamaerops humilis* L. var. *argentea* (Table 2).

On the 60th day, respective length measures were also taken on the 3 germination parts of each of the 20 samples (Table 3). The Cotyledonary Cords (CC) present a middle arithmetic percentage, 38.3% of the total length. The measured lengths vary between 3.9 and 6 cm. The Cotyledonary Ocrea (CO), with 3.1-5.1 cm, is statistically shorter with a middle percentage of 31.3%. The Radicle (R), with 30.4% is going to continue however to lie down

Table 2: Slopes and coefficients of regression of the samples

Samples	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Slope	2.21	2.74	2.84	3.93	1.56	1.04	2.43	2.26	1.62	1.61	2.22	3.25	1.89	1.74	2.39	3.00	3.16	2.98	2.06	2.27
Coef. reg. (r)	0.99	0.98	0.99	0.99	0.97	0.98	0.99	0.98	0.98	0.99	0.99	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Table 3: Lengths of elements on post-germination of 20 individuals

Samples (cm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CC	6.0	5.5	4.7	5.5	5.5	4.9	4.6	4.5	4.3	4.8	4.7	5.1	4.8	4.5	5.2	4.6	3.9	4.1	4.4	4.7
CO	3.5	3.2	3.1	4.8	4.5	4.3	3.9	3.7	3.6	4.1	3.3	3.7	4.1	3.6	4.3	4.1	4.2	3.9	5.1	4.2
R	6.0	3.1	2.3	3.2	5.9	3.5	2.0	1.7	6.8	5.0	2.6	3.2	5.0	4.9	2.7	4.4	4.5	4.1	3.8	4.5

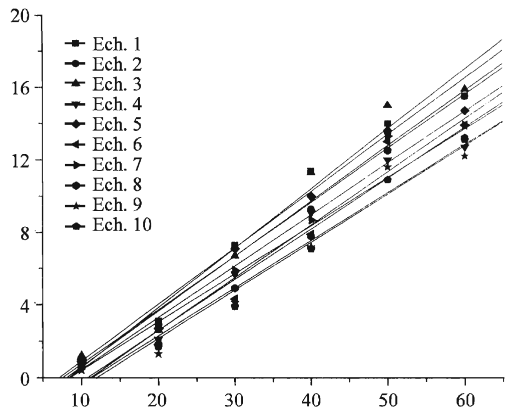

Fig. 3: Straight line of regression of the elongation of the germination elements of 10 individuals of *Chamaerops humilis* L. var. *argentea*

and to assure the forcing of the stipe in soil to give birth to the future roots. After a 60th day follow-up, the taken middle values of the plant are only of 13.9 cm, which explains the slowness of the development of the *Chamaerops humilis* L. var. *argentea.*

As for the kinetics of growth of post-germinal elements, taken separately, 20 samples show an average speed of development ranging from 0.1-0.028 cm day^{-1}.

The growth speed of the Cotyledonary Cord (CC) varies between 0.1 and 0.065 cm day^{-1} with an average of 0.080 cm day^{-1}. Whereas, the Cotyledonary Ocrea (CO) and Root (R) are smaller.

Indeed, it ranges from 0.052 and 0.085 cm day^{-1} for C.O. with an average of 0.066 cm day^{-1} and between 0.028 and 0.083 cm day^{-1} with an average of 0.058 cm day^{-1} for the Root (R).

The cumulative growth of 3 post-germ (CC; CO and R) ranges between 0.232 and 0.165 cm day^{-1}, an average of 0.204 cm day^{-1}.

The post-germination growth of the 1st components concerning the vegetation of *Chamaerops humilis* L. var. *argentea* is slow. We note that the growth regime is constant.

CONCLUSION

The obtained results in this survey show that the time of germination is about 36 days and that the germination spread on 25 days. In addition, this experimental condition proves that the 42nd day is the germination peak. The used treatment for the selected seeds improved the global rate of germination to 58%. In nature, <20% of the palms seeds germinate and >25% require 100 days to germinate (Meerow, 1994). In addition, the experimental conditions were maintained steady all along the experimentation and gave a positive impact on the responses of the seeds. The hydration and the temperature are 2 decisive factors for the increase of the percentage of palm seeds germination. The kinetic approach of the germination elements permits to clear 3 parts:

- Cotyledonary cord: responsible of the nutrition
- Cotyledonary ocrea: give the 1st leaves
- Radicle: gives the adventitious roots

Nevertheless, our follow-up of the plant growth and the kinetical study allows to highlight the slowness of this species development. This slow growth is probably related to the nature of this species.

Chamaerops humilis L. var. *argente*a Andre is a leading genetic resource plant in our region. Nevertheless, it poses problems in terms of conservation. The status of this heritage is continually deteriorating and its preservation requires concerted action. To contribute to its sustainability effective germination techniques must be taken into account. That is why; we have to set up studies based on *ex situ* methods of storage and seed germination activity to complement in situ conservation.

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