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GROWTH AND DEVELOPMENT OF *Eleocharis ochrostachys* Steud. REPRODUCED FROM ITS TUBERS

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ABSTRACT

In this study, the growth and development of *Eleocharis ochrostachys* were investigated in a control condition. Its tubers of the plant sprouted to produce stems after being cultured in plastic pots for several days. After 120 days, the plant grew to a height of 42.8 cm on average, stem diameters were from 1.5 to 2.0 mm, and the plant started to bloom and produce tubers. The plant spikelet had dimensions of 1.0–2.0 cm high, 2.0–2.5 mm wide after 120 days. The achenes were formed after 128–130 days, had dimensions of 1.15–1.20 mm long, and 0.5–0.7 mm wide when the plant was cultured for 150 days. The tubers had dimensions of 7.0–9.0 mm long, 4.0–6.0 mm diameter, and were about 0.06–0.1 grams after 150 days. This study provided information on the development of *Eleocharis ochrostachys* cultured in the greenhouse.

Keywords: *Eleocharis ochrostachys*, growth, development, tubers, achene.

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INTRODUCTION

Eleocharis ochrostachys Steud. or *E. ochrostachys* Boeckeler was first described by Steudel (1955). The plant is commonly known as spike rush, which is native to Australia and Asia. The plant naturally grows in wet areas such as swamps, creek lines or damp depressions. In Viet Nam, *E. ochrostachys* is mostly found the Mekong Delta (Quan et al., 2018). Tram Chim National Park is a wetland of international importance under the Ramsar Convention, where *E. ochrostachys* grassland is one of the main ecosystems. *E. ochrostachys* is a native grass in the Park, and its tubers are considered to be the main food source for a crane named *Grus Antigone sharpie* (Huynh Thach Sum et al., 2016).

In the flood season, most areas of *E. ochrostachys* ecosystem in Tram Chim national park are submersed underwater level (Nguyen Phan Minh Trung, 2012). However, this ecosystem becomes dry, and most areas of this grass are above water level around the canals in the dry season (Nguyen Van Manh, 2010). Obviously, the growth of *E. ochrostachys* depended on the ecological conditions (Truong Thi Nga & Nguyen Van Manh, 2011; Huynh Thach Sum et al., 2016). However, the report on the growth of *E. ochrostachys* in agricultural conditions such as in pots and greenhouses is still lacking. Moreover, some characteristics of the plant such as growth, tuber and fruit development have not been documented yet.

In recent years, climate change has caused damages to ecosystems, which negatively affects the development of living species. Annually, the levels of floodwater are unstable in the Park, and some years flooding even do not occur. Besides, water is blocked inside the forest by water-wall to prevent forest fire, which may be somewhat unsuitable for the ecology, and may affect the development of *E. ochrostachys.* The plant does not produce or poorly produce tubers in drought conditions. The growth of the plant under dry conditions was studied (Huynh Thach Sum et al., 2016), and under flooding, water was reported (Truong Thi Nga & Nguyen Van Manh, 2011), but no paper has described the development of *E. ochrostachys* under normal condition. Moreover, the plant can reproduce sexually from seeds and asexually from tubers. Therefore, the present study aimed to investigate the growth and development of *E. ochrostachys* reproduced from its tubers in the soil to fill the existing knowledge gap.

MATERIALS AND METHODS

The tubers from the plant naturally growing at A5 area in Tram Chim National Park, Tam Nong District, Dong Thap Province (10º45’34.2”) was used to a culture in pots. The mature plants of *E. ochrostachys* were dug up, and only tubers were collected. Moreover, the soil was collected at the surface layer (0–20 cm depth) at which *E. ochrostachys* naturally grew. Surface water was also taken out from a canal inside the Park. The soil and water pH were 3.74 and 5.9, respectively. Other soil components included 15.00 ± 0.71% organic compounds, 0.32 ± 0.02 mg available nitrogen and 43.1 ± 1.29 mg available phosphor per 1.0 kg dry soil. Soil EC was 3.24 mS/cm. The plant tubers, soil and water were transported to laboratories within the day. Soil samples were ground and removed large debris to obtain a soil size smaller than 2.0 cm. The soil was dried under sun rays for ten days before being used for culturing.

Cylinder plastic pots (25 cm high, 25 cm diameter on the top and 20 cm diameter at the bottom) were filled with 3.5 kg dry soil. Water collected from the Park was added to 80–100% of the soil water-holding capacity. The soil moisture was maintained by sprinkling water daily. Each pot was sown with nine tubers. Tubers were buried underground at depths of 3–5 cm. The pots were placed in a Biological Garden, Dong Thap University. The plant was cultured for 150 days, and water was sprayed every day. The experiment was conducted with 9 pots. Some plants were dug and

cleaned with tap water to measure the roots and tubers during the time.

RESULTS AND DISCUSSION

The growth of formation of tubers

E. ochrostachys is usually asexually reproduced. Clonal development is the most common mechanism for spreading wetland vegetation, including *E. ochrostachys* species (Kapa & Clarkson, 2009). In this study, each tuber started to produce new plants from tubers several days after being cultured. The new stems with the green colour of chlorophyll were about 2.0–3.0 cm in height after 15 days (Fig. 1a), and plumules embayed by leaf scales were formed at the base of the first culm (Fig. 1b). The plumules and radicles were produced from underground rhizomes. The rhizomes were embayed by leaf scales, but these leaf scales were died soon and did not exist or were torn on the old rhizomes.

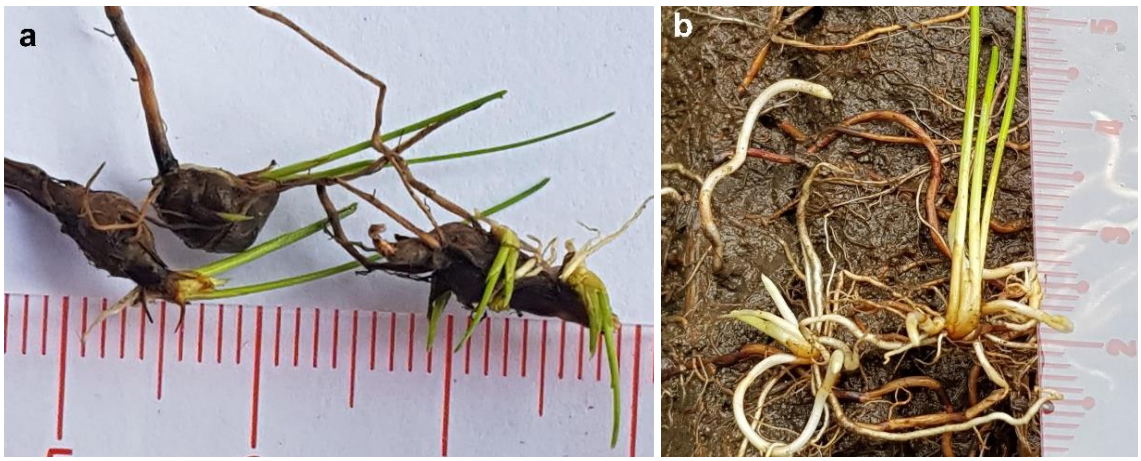

Figure 1. (a) stems and (b) stems and radicles produced from tubers cultured for 15 days

After one month, stem height reached 18.8 cm on average. Rhizomes developed other stems running underground horizontally. Roots penetrated down into the soil (Fig. 2a). Several stems are produced from shallow rhizomes. The plant continued growing and stems heights reached 24.5, 32.7 and 42.8 cm on average after 60, 90 and 120 days, respectively. Its stem diameters were from 1.5 to 2.0 mm, and roots were from 7.5 to 10.5 cm long after 120 days. After that time, the parameters of plant height, diameter and root length did not significantly increase. The tallest stems were about 50 cm after 150 days. In Tram Chim National Park, the plant was usually not over 15 cm tall in the dry season (Huynh Thach Sum et al., 2016), but it grew to 155.7 ± 6.37 when it was submerged in floodwater (Truong Thi Nga & Nguyen Van Manh, 2011). In other reports outside Viet Nam, *E. ochrostachys* growing in Andaman & Nicobar Islands was 40–90 cm long (Chandore et al., 2015), and in Australia was about 40–60 cm (Zich et al., 2020).

The plant had a pipe barrel stem; plants formed dense tufted clumps, edgeless bush, thin-spongy stems and were somewhat flattened. Its leaves atrophied to short sheaths at the base of the stem, straight leaves with sharpish tips, no leaf blade were observed. Stems were tubular in shape with a thin membrane. Leaf base was reddish. The plant started to bloom after 120 days old (Fig. 2c). Subsequently, *E. ochrostachys* produced seeds, young tubers in the soil.

The rhizome of the plant was horizontal underground, which produced aerial stems. Then, it grew upright to form photosynthetic

aerial stems (Fig. 2b). Roots were also produced in rhizomes nodes, from tubers and from internodes. Each internode of rhizomes was 15 mm long on average. The stems developed to photosynthetic organs, while leaves were reduced to sheaths. The plumules at the end of rhizomes and tubers did not grow, or increased their diameter to become tubers, or grew above the ground into aerial stems.

Figure 2. The species *Eleocharis ochrostachys* after being cultured for (a) 30 days and rhizome of the plant was horizontal underground, then it grew upright to form photosynthetic aerial stems (b) after 90 days. The inflorescence was formed after 120 days (c)

The features of spikelet and fruit

After blooming, stem tips formed single spikelets which were egg-shaped to lance-oblong in outline, from rounded to blunt at the tip. The spikelets had the dimension of 1.0–2.0 cm high, 2.0–2.5 mm wide (Figs. 3a, 3b and 3c). Each spikelet had 12–30 florets tightly packed and spirally arranged. Each floret was subtended by a single scale. Scales were 1.0–2.0 mm long, 1.0–1.5 mm wide, rounded at the tip, orange-green to straw-coloured with a straw-green midrib that dries brown. The lowest scale in the spikelet was broader than the rest, surrounds about 2/3 of the stem, and lacks a flower.

The fruits of *E. ochrostachys* were achenes with brown colour and had fine stripes. The achenes were formed after 128–130 days. Each flower produced a single achene (seed) that drops off independently of the scale. The achene with a cap-like appendage (tubercle) at the tip that was clearly distinct from the rest of the achene. These characteristics were also described in previous reports (Vo Van Chi, 2003; Pham Hoang Ho, 1999). Each achene was from 1.15 mm to 1.20 mm long, from 0.5 mm to 0.7 mm wide, green-coloured to dark brown, smooth across the surface, lens-shaped in cross-section, urn-shaped in outline, rounded at the tip end and tapering at the base (Fig. 3d). Seeds were encased in a fruit coat that had bristles. Tubercles were greenish to brown, broadly triangular. There was no stalk or constriction between the top of the achene and the base of the tubercle. Surrounding an achene was 3–7 perianth bristles, brown bristles, slightly longer to much longer than the achene. These results agreed with the characterization of *E. ochrostachys* naturally growing in Australia described in a previous report (Zich et al., 2020). In another report, *E. ochrostachys* growing in Andaman & Nicobar Islands had spikelets cylindrical to oblong-elongate, broader than culm, 1.0–3.0 cm long, 2.5–4.0 mm thick and many-flowered (Chandore et al., 2015). Its glumes were ovate to ovate-oblong, 4.0–4.5 × 2.0–3.0 mm (Chandore et al., 2015).

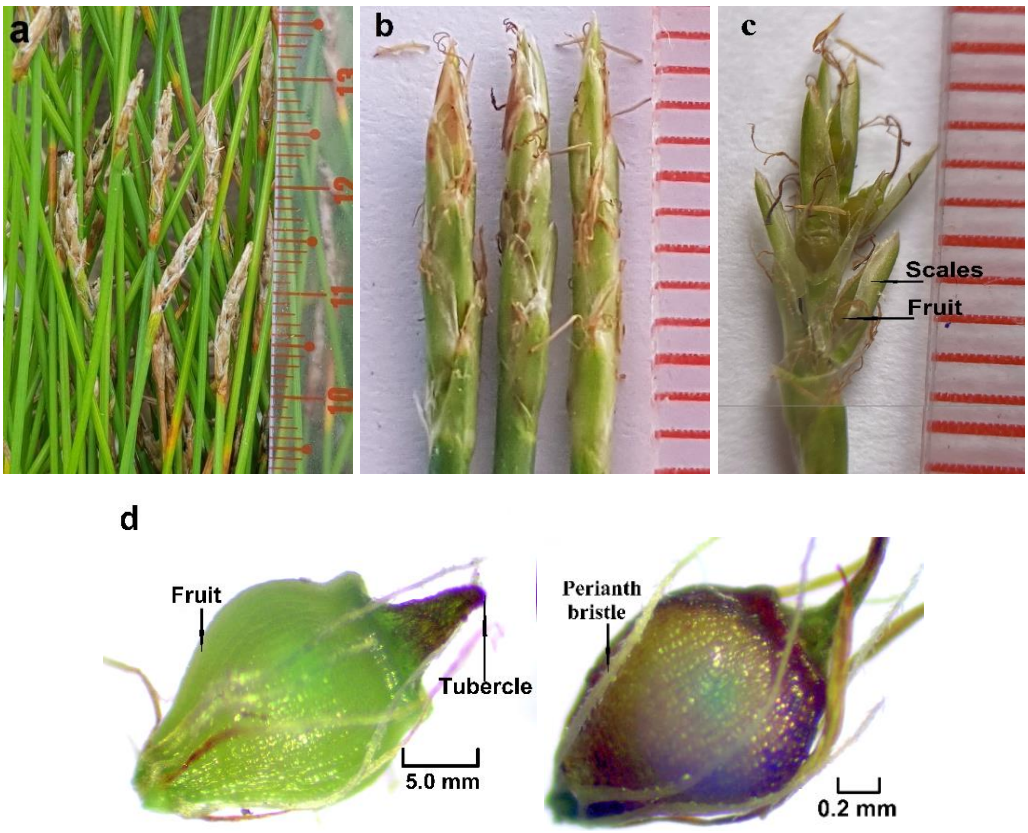

Figure 3. The spikelet at the tip stem (a). The scales are greenish, to fold helical (b). A fruit is started to be produced and embayed by scales (c), and mature fruit (d)

The development of rhizome and tubers

Tubers were formed from plumules at the end of rhizomes when the plant was cultured for 120 days (Fig. 4a) or from pre-existing tubers. The internodes at the end of rhizomes were shortened, bulged, grew in diameter to form tubers. Each tuber usually had 4 to 6 internodes. Each internode of tubers was about 1.0–3.0 mm, while each rhizome was about 8–15 cm. The plant produced root-tubers which could be observed after about 120 days. The tubers grew quickly and had parameters of 7.0–9.0 mm long and 4.0–6.0 mm diameter after 150 days. The tuber's weight was about 0.06–0.1 g/one.

Figure 4. (a) tuber after 120 days (b) 140 days and (c) 150 days

The tubers were egg-shaped or oval-shaped, which had white colour at young (Fig. 5a), and reddish-brown at old-time (Fig. 5b). The inside of the tube was white, brittle (Figs. 5c, d). The cross-sectional anatomy of tubers showed vascular bundles, axial parenchyma and ray parenchyma. Vascular bundle distributed dispersedly in the tubes similar to stems of monocotyledon plants. The parenchyma in the tubers contains starch.

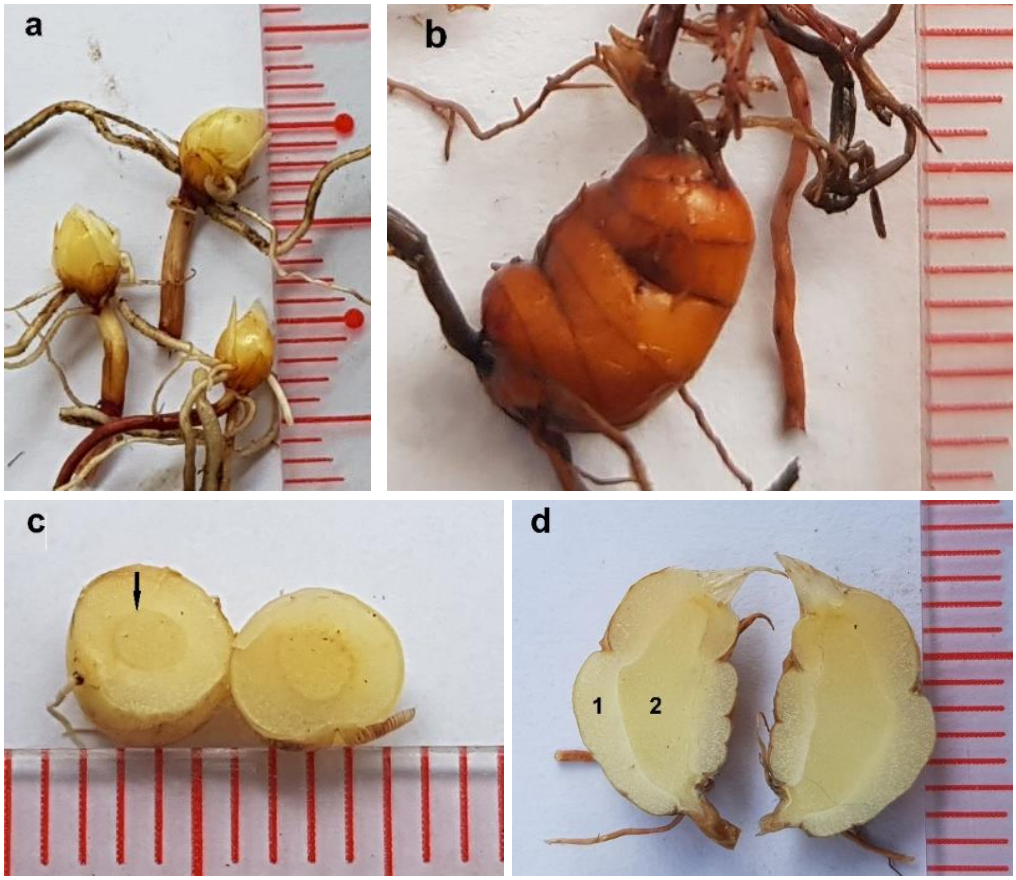

Figure 5. Tubers of the species *Eleocharis ochrostachys*: (a) young tubers, (b) old tuber and (c) and (d) across the section. The cross-sections of tubers show cambium ring (arrow), (1) cortex and (2) parenchyma

CONCLUSION

E. ochrostachys natural growing in Tram Chim National Park was cultured and controlled in an agricultural condition. The plant grew to maximum height after 120 days with 42.8 cm on average. The plant also produced tubers and flowers after 120 days. Subsequently, *E. ochrostachys* produced seeds, young tubers in the soil. To the best of our knowledge, his study is the first report on the time-course development of *E. ochrostachys*.

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