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Studies on the Growth-development Law and Suitable Period for Harvesting of *Pinellia ternata* (Thunb)Breit

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Abstract

Objective: Find out the growth-development law of *P. ternata*, and offer references for suitable period for harvesting and standardized cultural technique. Methods: Periodic sampling, investigation and measurement; Results: Dynamic change of each growth index all show a similar rule, namely that with the elongation of growth-development course, it was characterized an "S" type curve, and peak values are observed during the first "inverted seedlings" period. Especially, average drying rate of tubers during the first "inverted seedlings" period is significantly higher than that during the second period. Conclusions: Initial stage of the first "inverted seedlings" is quite suitable period for harvesting of *P. ternata*, and thus its utilization value is further efficaciously enhanced.

Keywords: *Pinellia ternata (*Thunb) Breit, Growth-development law, Drying rate, Suitable period for harvesting

1. Introduction

Pinellia ternata (Thunb) Breit is perennial herb, and belongs to species of *Pinellia*, the family of *Araceae*. Such species was the recorded toxic grass and plant in Chinese Plant Atlas Database, and its toxicity exists in all individual plant with more in tubers. Meanwhile it also possesses certain medicinal values, viz. transform phlegm and stop coughing, stop nausea and vomiting, address goiters or scrofula, ease pain, anti tumor and so on(2005, PP.78-79). With the increasing demand from market, studies on the cultivation technology for high produce of *P. ternata* have been strengthened. Proclamation of regulations titled "Chinese medicine materials production quality and management regulations" required that the production of medicinal materials should make relative planting regulations and cultivation measures according to their biological characteristics (Ren, 2003, PP. 12-17). Currently, correlated researches on the growth-development characteristics of *P. ternata* cultivation were not yet available. Therefore, studies on the growth-development law of *P. ternata* would be of great significance to ascertain its optimum period for harvesting, implement standardized cultivation and thus enhance its quality and yield.

2. Materials and methods

2.1 Materials

Tested *P. ternata* were sampled from Huohua, Nanchong of Sichuan Province.

2.2 Methods

2.2.1 Cultivation management of *P. ternata*

P. ternata plants were planted in Huohua trail base of Nanchong, Sichuan on March 2rd, 2003. Drill was undertaken in the experimental field with plots of $10m^2$(2m×5m). Protection rows were made around the field. Tubers with no disease and the diameter of 1cm or so were selected as seeds, and planting manner was hill seedling. Experimental field was fertilized according to the unified standard, and fertilization level was 2000kg local decomposed manure from pig and cattle yard per acre with 250kg gingko leaf residues and 50kg decomposed oil cake. Cultivation management throughout the trial was identical, and timing irrigation and weed removal by manual work were undertaken.

2.2.2 Cardinal biological characteristics observation of *P. ternata*

During the different growth and development periods such as seedling, full seedling, centralized emergence of bulbil, centralized emergence of spathe, and inverted seedling, 30 samples were collected at random, and divided into 3 groups, each group 10 samples. Indices during different periods such as plant height, compound leaf number, length and width of main leaf, bulbil number and diameter and so on, were measured indoor. Fresh weight of total plant and tubers were

assayed, and then dried at 60℃ for 48h. Dry weight of them was assayed subsequently. According to that analysis, growth-development law of *P. ternata* was ascertained.

3. Results and analysis

3.1 Dynamic change of plant height

Plant height increased with the breeding course after the first "inverted seedlings" period, rapidly grew from seedling to centralized emergence of spathe, attained top value during the period of centralized emergence of spathe, and then kept stable. During the second "inverted seedling" period, dynamic changes of plant height showed a growth trend "slow-fast-slow", and attained peak value during the period of centralized emergence of spathe, higher than those during the second "inverted seedling" period, and then decreased gradually(Figure 1).

3.2 Dynamic change of leaf

Leaf of *P. ternata* was ternate compound leaf, and its compound leaf number increased with the elongation of growth and development course, attaining top values during the period of centralized emergence of spathe. The number of leaf is 3.63 in the earlier half year growth-development period and 2.27 in the later half year, and then decreased gradually. Finally, leaves turned yellow and withered to death during the period of inverted seedlings (Figure 2).

As seen from Figure 3, main leaf length of *P. ternata* showed a similar changing trend during the period of growth-development in earlier and later half year, namely that it increased gradually along with the course of growth-development. It attained top value during the period of centralized emergence of spathe and decreased slightly afterwards.

As seen from Figure 4, main leaf width showed an approximately similar changing trend during the second inverted seedlings period and earlier half year, namely that it increased gradually along with the course of growth-development. It attained top value during the period of centralized emergence of bulbil and decreased slightly afterwards.

3.3 Dynamic change of bulbil number and diameter

As seem from Figure 5, average bulbil number per *P. ternata* showed an identical changing law during the period of the second inverted seedlings and in earlier half year, and attained the rapidest increment from the period of centralized emergence of bulbil to spathe, achieving peak value during the period of centralized emergence of spathe. It was 2.47 during the first inverted seedlings period, 2.50 in the later half year and then remained stable afterwards. Bulbil diameter kept the increasing trend during the first inverted seedlings period, increased slowly from the period of centralized emergence of bulbil to spathe, and increased promptly from the period of centralized emergence of spathe to inverted seedlings (Figure 6).

3.4 Dynamic change of tuber fresh weight, dry weight and drying rate

Tuber fresh weight varied greatly during the first growth-development period, showed an obvious ascending trend from the period of seedling to inverted seedling, decreased slightly during the period of total seedling, then increased promptly subsequently, attained peak value during the period of centralized emergence of spathe and decreased slightly during the period of inverted seedling(Figure 7). Tuber dry weight also decreased slightly during the period of total seedling, attained peak value during the period of centralized emergence of spathe, and then kept stable afterwards(Figure 8). During the second period of growth-development, tuber fresh weight decreased slightly in total seedling period, increased slowly and kept stable subsequently. Compared to the initial seedling, the increment was not significant (Figure 7). Tuber dry weight showed a decreasing trend as a whole during the second period of growth-development (Figure 8). As seen from calculation results, tuber drying rate attained the top value, namely 34% during the period of centralized emergence of bulbil in the second growth-development. It attained the valley value of 23% during the period of centralized emergence of spathe, and then increased to 29% during the period of inverted seedling. As for the second growth-development period, the highest drying rate occurred during the period of total seedling and attained 33%; while the lowest occurred during the period of inverted seedling and attained 18%. In general, average drying rate in the first inverted seedling was larger than that in the second inverted seedling.

4. Conclusions and discussions

Among all growth indices, indices such as plant height, compound number, length and width of main leaf, bulbil number per plant, bulbil diameter, fresh and dry weight, tuber fresh and dry weight, showed a similar rule of dynamic change, namely increased with the elongation of growth and development course. Their growth-development curves were all characterized as S type curve, in line with logistic equation, and top values all were attained during the first inverted seedling period. Especially, the highest tuber drying rate in the first inverted seedling period was significantly larger than that during the second one. As seen from the accumulated dynamics of total alkaloid, peak value was attained in the initial stage of the first inverted seedling period (Li, 2006, PP. 687-688). Therefore, in order to enhance the utilization value of *P. ternata* tuber, and quality and yield of *P. ternata*, the initial stage of the first inverted seedling period was the suitable period for harvest, and it would be optimum when leaf stem didn't wither to fall down.

Indices, such as fresh and dry weight of plant and tuber, showed a similar changing rule during the first and second inverted seedling period. They all decreased slightly or increased insignificantly during the period of total seedling compared to seedling period, and in light of this result we postulated that with the bourgeon of tuber after seedling, nutrition consumed, and photosynthetic accumulation was lower than decomposition; After total seedling, photosynthetic accumulation dominated, dry substance accumulation increased and attained the highest level till the centralized emergence of spathe; During the centralized emergence of spathe, *P. ternata* turned into reproductive growth phase from nutritional growth, and reproductive growth of *P. ternata* certainly would consume the nutritional substances deposited in the tubers. Nutritional provision center shifted to reproductive organs. Secondly, due to the inverted seedling period, high temperature and illumination in summer withered above-ground leaves to yellow discolouration or even falling off, leaf number and area decreased, photosynthesis attenuated, tubers tended to physiological dormancy, substances accumulation increased insignificantly or accumulation was lower than decomposition, and plant transferred from photosynthetic accumulation into consumption. Accordingly, fresh and dry weight of plant and tuber decreased slightly or kept stable during the period from centralized emergence of spathe to inverted seedling.

P. ternata growth-development was divided into 5 periods, viz. seedling, total seedling, centralized emergence of bulbil, centralized emergence of spathe, inverted seedling. In the practical produce, suitable cultivation measure should be undertaken, aimed at high quality and yield according to the growth characteristics of different growth-development period. During the period of seedling and total seedling, measures such as adding fertilizer, cultivation and so on should be undertaken, with attempt to promote the emergence of leaves, and built a base for the growth in the middle or later stage, especially for the formation of bulbil. Due to the association between compound leaf number and bulbil number, more compound leaves, more bulbil. According to the theoretical calculation, 3 leaves per plant would produce 3 bulbils. If inverted seedling occurred 3 times per annum, it would result in 64 different tubers and bulbils (Gu, 1994, PP. 44-48). During the period of centralized emergence of bulbil and spathe, field management should be strengthened, such as timely weeding and irrigating, prevention of plant diseases and insect pests and drought, proper sheltering, and suitable complement of fertilizer, with attempts to the produce of bulbils, enlargement of tubers, elongation of leave functional period, prevention of leaves from reaching inverted seedling period due to earlier wilt, and guarantees of nutritional substances bulbil formation and tuber augment required. Increment of tuber dry substances accumulation could also be obtained by removing spathes and attenuating the nutritional consumption due to reproductive growth, and thus high yield would be achieved.

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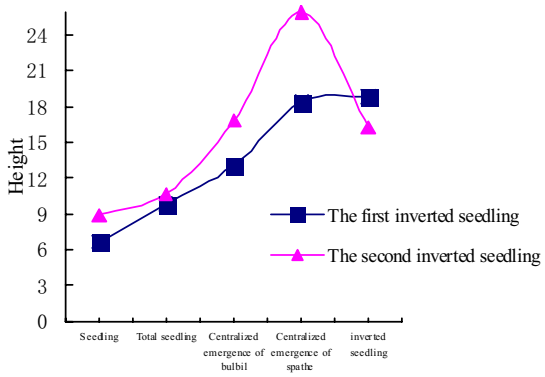

Figure 1. Dynamic change of plant height in *P. ternata* during different growth-development period

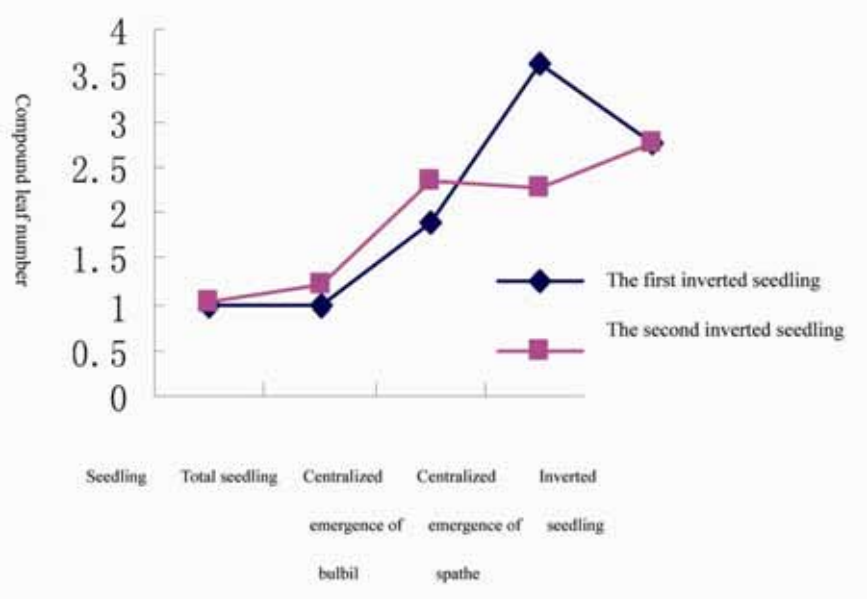

Figure 2. Dynamic change of compound leaf number in Pinellia during different growth-development period

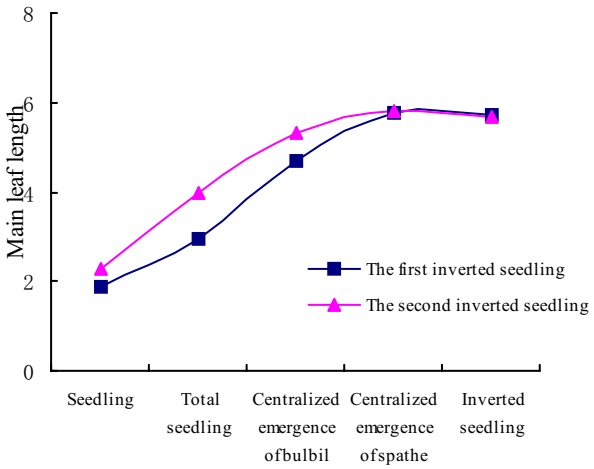

Figure 3. Dynamic change of main leaf length in *P. ternata* during different growth-development period

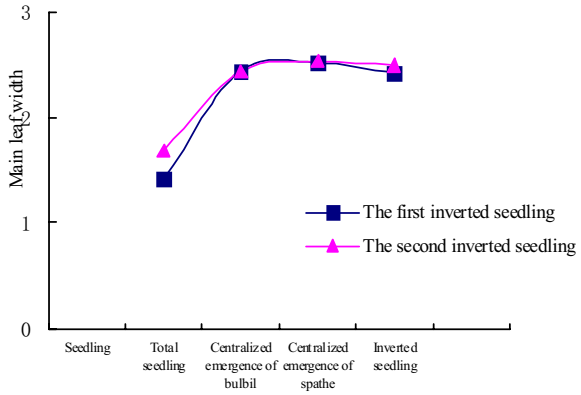

Figure 4. Dynamic change of main leaf width in *P. ternate* during different growth-development period

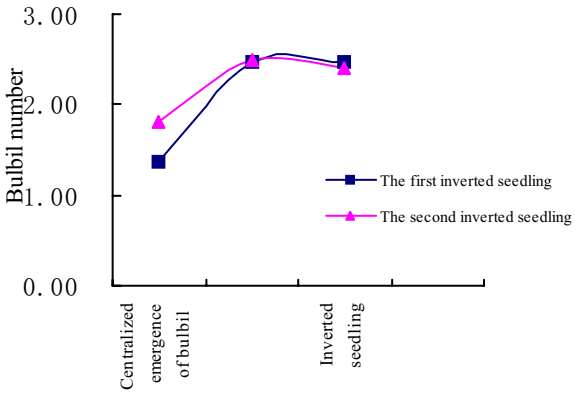

Figure 5. Dynamic change of bulbil number in *P. ternata* during different growth-development period

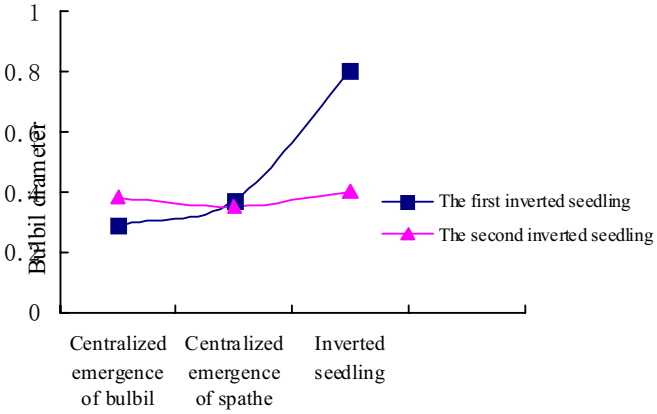

Figure 6. Dynamic change of bulbil diameter in *P. ternata* during different growth-development period

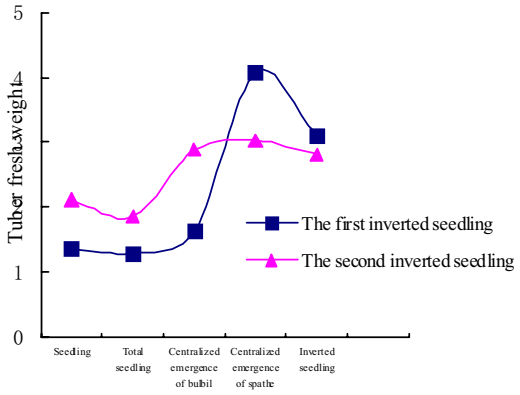

Figure 7. Dynamic change of tuber fresh weight in *P. ternata* during different growth-development period

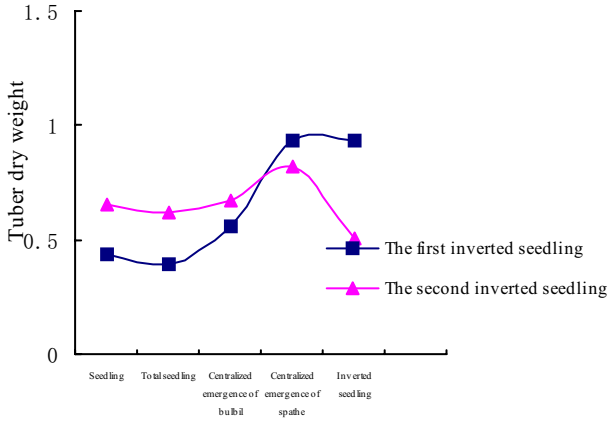

Figure 8. Dynamic change of tuber dry weight in *P. ternata* during different growth-development period