

Study on the Effects of Different Media on the Seeding of *F. cirrhosa* at Plateau

Ye Hu¹, Meng Ye¹, Yong Dai^{2,3} & Kai-hua Han³

¹ College of Forestry, Sichuan Agricultural University, Ya'an, Sichuan, China

² Chinese Medica Department, Chengdu University of TCM, Chengdu, Sichuan, China

³ Chengdu Enwei Investment Group Company, Chengdu, Sichuan, China

Corresponding author : Meng Ye, College of Forestry, Sichuan Agricultural University, Ya'an, Sichuan, China.
Tel: 86-133-3060-0231. E-mail: yemeng5581@163.com

Received: August 16, 2013 Accepted: October 23, 2013 Online Published: November 15, 2013

doi:10.5539/jas.v5n12p14 URL: <http://dx.doi.org/10.5539/jas.v5n12p14>

Abstract

Bulbus *Fritillaria cirrhosa* is a precious wild herb of Liliaceae *Fritillaria* which grows in Tibetan area of China. Ripe seeds and one- year bulbs of *Fritillaria cirrhosa* D. Don were planting materials. Sandy soils, humus soils and humus soils with the dung of Hepialidae Larvae (Lepidoptera, Hepialidae) were selected as nursery materials. The experiments were conducted at Xinduqiao Town of Kangding County (Latitude: 101°, 34'N, longitude: 30°, 03' E, altitude: 3500 m) from March to August in 2011. The research was aimed to select the optimum medium of productive seeding and to study on effects of different media on growth of *F. cirrhosa* seeding. The results were: (1) Sowing with seeds and one-year-old bulbs of *F. cirrhosa*, S1 (100% humus soils with dung of Hepialidae larvae) was the best nursery media for sprouting. (2) The integrated performance was considered, including transverse diameter, longitudinal diameter, the ratio of longitudinal diameter to transverse diameter, 30-grain fresh weight and 30-grain dry weight. Sowing with *F. cirrhosa* seeds, S1 (100% humus soils with dung of Hepialidae Larvae) was the best medium for promoting the seedlings and getting larger size of bulbs. Sowing with one-year-old *F. cirrhosa* bulbs, S1 (100% humus soils with dung of Hepialidae Larvae) and S2 (100% humus soils) were advantageous for the growth of plantlet bulbing and getting larger size of bulbs. Adding sandy soil to substrates or 100% sandy soil as nursery media could inhibit the growth of *F. cirrhosa* bulbs, getting better shape of *F. cirrhosa* bulbs.

Keywords: *Fritillaria cirrhosa* D. Don, nursery media, seeding, one-year-old bulbs, two-year-old bulbs, sprouting percentage, shape of bulbs, biomass

1. Introduction

The cultivation of medicinal plant can effectively solve the shortage of herbal source drugs or remedies and largely reduce pressure on excess exploitation of wild herbs (WHO et al., 1993). Germplasm resources are not only an important part of biological resources, but also a key to success for cultivation (Srivastava et al., 1996). At present, more than 250 species of medicinal plants are commercially cultivated on about 380,000 ha in China (Canuto et al., 2012). Media are the base of the material needed for plant growth, providing moisture and nutrients for crop root, affecting plant physiology and yield heavily (Sonned, 1991). So a key to achieve industrial development of Chinese herbal medicines is to get a suitable media. Currently, the herbs had been studied on nursery media, such as *Carthamus tinctorius* L. and *Atractylodes macrocephala* Koidz (Rao-sheng, 2011, 2010).

Bulbs of *Fritillaria cirrhosa* is one of the most widely used traditional Chinese medicines with the function of relieving cough and eliminating phlegm (Chinese Pharmacopoeia Commission, 2010). Bulbs are not only medicinal parts of *Fritillaria cirrhosa*, but also a breeding material. The quality of bulbs is related to yield and quality of the *Fritillaria cirrhosa*. *Fritillaria cirrhosa* (Liliaceae, *Fritillaria*) is a kind of endemic and rare perennial herbs which grows in a limited area in the Tibetan plateau. Severe plateau climate causes to slow growth and reproduction. One time "sprouting" and so-called "sprout tumble" were observed within a year (Editorial Committee of Chinese Academy of Sciences 'Flora of China', 1980). The artificial cultivation of *Fritillaria cirrhosa* has been carried out in 1960s. 3 years cultivation for *Fritillaria*

Fritillaria cirrhosa could ensure its economic characteristics (Jun et al., 2009; Da-yong et al., 2010). In recent years, studies on cultivation of Bulbuls *Fritillaria cirrhosa* are concerned with those aspects: (1) contrasting with wild materials in efficacy of active ingredient (Congetal, 2010; Xiao-yan et al., 2009), (2) cultivation techniques. Cultivation techniques of Bulbuls *Fritillaria cirrhosa* have a breakthrough. Current research has defined the basic ecological factors closely related to quality of Bulbuls *Fritillaria cirrhosa*, including soil, climate and the surrounding biological community ecology (Hui et al., 2008). Bulbuls *Fritillaria cirrhosa* have different qualities because of that the significant factors are different in the contents of soil elements K, Mn, Zn and P (Shi-lin et al., 1990). Humus soil has been selected as a better media for the growth of seeding, because Bulbuls *Fritillaria cirrhosa* have achieved comparatively high germination rate and comparatively good quality in humus soil (Ying-ying, 2008).

In this paper, based on previous studies, under the nursery mode of shed, author selected 4 kinds of media and adopt the ripe seeds and one- year-old bulbuls of *Fritillaria cirrhosa* D.Don as plant materials to study on the effects of different media on growth of *F. cirrhosa* breeding bulbuls. The result of this paper is to provide a research base for the industrial development of Bulbuls *Fritillaria cirrhosa*.

2. Materials and Methods

2.1 Plant Material

Ripe seeds and one- year bulbuls of cultivated *Fritillaria cirrhosa* D.Don were collected in Xinduqiao Town, Kangding Country, Sichuan Province (Latitude: 101°, 34'N, longitude: 30°, 03'E, altitude: 3500 m) in August, 2011. The seeds and one-year bulbuls were placed in humus and broken dormancy. Seed embryonic development achieved normal. One-year-old bulbuls were longitudinal dia. 0.180-0.538 cm, ave. 0.343 cm, transverse dia. 0.200-0.472 cm, ave. 0.305 cm and the ratio of longitudinal dia. to transverse dia. 1.00-1.15, ave. 1.13.

2.2 Nursery Media

Author chose media which was common used for cultivation. Sandy soils, humus soil sand humus soils with the dung of Hepialidae Larvae were selected as nursery materials. Sandy soils were collected from Xinduqiao Town. Humus soils were purchased from Yi Bin, Sichuan Province. Humus soils with the dung of Hepialidae Larvae were collected from Chengdu Enwei Group.

2.3 Local Conditions

The experiment was carried out in Mar. 27 2012 with the shed (span: 8 m, length: 25 m, height: 3.8 m, light transmittance: 30%) in Xinduqiao Town, Kangding Country, Sichuan Province. The climate is the plateau continental monsoon. The annual mean air temperatures were 209.56°F. The annual rainfall was 922.7 mm. The annual frost free time was 2525.9 h. The annual frost free time in a year was 95 days (Jun et al., 2009).

2.4 Breeding Experiment

The experimental design was a single factor with 4 level sand randomized in complete blocks with three replicates. Three kinds of media were sifted with sieve (10 meshes). Four nursery media were S1 (100% humus soils with dung of Hepialidae Larvae), S2 (100% humus soils), S3 (50% humus soils +50% sandy soil) and S4 (100% sandy soil). The test numbers for sowing with seeds were marked as SS1, SS2, SS3, and SS4. The test numbers of sowing with one-year-old bulbuls were SB1, SB2, SB3, and SB4. Seedbed (length: 7 m, width: 1 m, height: 0.06 m) was set up in the shed. Seedbed was split up into plots (length of each plot: 1.00 m, width of each plot: 0.25 m, size of each plot: 0.25 m²) with bricks. Organic mulch was put at the bottom of each seedbed. The time of sowing was Mar 2011. The density of seeds was 10000 per square meter. The density of one-year bulbuls was 5000 per square meter. Irregularly watering and weeding, monthly observing and recording the growth status of seeding were until 'sprout tumble', in other words, the aboveground part of plant had the state of being wilted and lodging.

2.5 Observations

Bulbs weight and size were recorded after 'sprout tumble'. To record the size and to record the fresh biomass yield (Table 1), 30 bulbuls were randomly selected from each plot, wiped with a clean, damp cloth or gauze pad, and measured by caliper. The bulbuls were dried at 1,859°F to a constant mass for 48h. The media samples were taken back to Sichuan Agriculture University in March 31, 2012. Substrates samples were taken at the beginning of Mar with cutting ring V100 cm (Φ50.46×50).

Soil physic factors were measured as described by Guang-song (1996): Water content in soils was measured with oven drying method; soil bulk density (BD), total porosity (TP), aeration porosity (AP) and water retaining porosity (WRP) were measured with cutting ring method. In addition, the soil chemical factors were measured as

described by Ru-kun (1999): soil pondus hydrogenii (pH) in water was measured with potentiometer; organic matters were measured with potassium dichromate oxidation and heating method; the cation exchange capacity (CEC) was determined by the ammonium saturation method; total nitrogen (N) was with semimicro-Kjeldahl determination; total phosphorus (P) in the extract was determined by the ascorbic acid-molybdate blue; total potassium (K) was with the flame atomic emission spectrophotometer; hydrolysable nitrogen was with determination of hydrolysable nitrogen; available P was with Mo-Sb colorimetric method; available K was with neutral ammonium acetate digestion and flame photometers method.

2.6 Statistical Analyses

Statistical analyses were carried out by SPSS v19 (SPSS Inc., Chicago, USA). One-way ANOVA with Fisher's LSD tests were performed to examine sprouting percentage, shape indexes and biomass of bulbs for the different treatments. The Correlativity Analyzing tests were used to test the relations between pH with sprouting percentages. Correlativity Analyzing tests were used to test the relations among BD, Hydrolysable N with shape of bulbs. Significance was determined at $p=0.05$.

3. Result

3.1 The Physicochemical Properties of Media

The physical properties of the media have a great influence on the cultivation of crops growth. Bulk density (BD), total porosity (TP), aeration porosity (AP) and water retaining porosity (WRP) were important traits (Li-hong, 2004). In this test, the physicochemical properties of media were showed in Tables 2 and 3.

The AP values of S1, S2, S3 and S4 were 21.10%, 25.48%, 31.88% and 30.01%, respectively. The AP values of the four media were in the range of 20-35% for nursery media (Kssica, 1997; Li-hong, 2004). In the four kinds of media, BD, TP, AP and WRP value of only S2 were in the suitable range as nursery media (BD: 0.2-0.8 g/cm³, TP: 40-65%, AP: 20-35%, WRP: 20-30%) (Kssica, 1997; Li-hong, 2004). It explained that the physical properties of S2 (100% humus soils) were relatively better.

The pH values of all treatments were in the suitable range (5.3-7.0) of main crops growing in media (Shi-zhe, 2001). The highest value of organic matter, total nitrogen and hydrolysable nitrogen was S2 (100% humus soils). The highest value of total phosphorus (P), totalpotassium (K), available phosphorus (P) and available potassium (K) was S1 (100% humus soils with dung of Hepialidae Laravae). The data from the determination of cation exchange capacity (CEC) showed: S2 (71.9%)>S1 (48.5%)>S3 (39.2%)>S4 (4.12%). The CEC was used to evaluate the capacity of soil fertility conservation. So the data of CEC indicated that humus soil contained soluble salt, and the sandy soils have very low capacity of nutrient supplying.

3.2 Sprouting Percentage

The germination rates varied in different nursery media (Table 4). The greatest degree of sprouting (63.25%) was observed of *F. cirrhosa* in sowing with seeds for SS1 followed by SS2 and SS3. SS4 showed very poor sprouting with mean values of 48.40%. The greatest degree of sprouting (91.30%) was observed for SB1 of *F. cirrhosa* in sowing with one-year-old bulbs—it was significantly higher than all other treatments. The application of SB2, SB3 and SB4 had no significant effect on the sprouting rate of *F. cirrhosa* in sowing with one-year-old bulbs. The study revealed that the germination rate of ripe seeds was significantly less than one-year bulbs. Sowing with seeds and one-year-old of *F. cirrhosa*, S1 (100% humus soils with dung of Hepialidae Laravae) was the best nursery media for sprouting rate.

pH had high significant negative correlation at the 0.05 level with sprouting rate of *F. cirrhosa* seeds with correlation coefficient of 0.966 and also had significant negative correlation at the 0.01 level with sprouting percentage of *F. cirrhosa* one-year-old bulbs with correlation coefficient of 0.960 (Table 5). It explained that pH had significant influence on sprouting percentage of *F. cirrhosa* seeds and one-year-old bulbs. Based on former researches in crops such as cole and paddy, the best pH for seed germination of different crops was different and pH had significant effects on amylase, protease and lipase during seed germination, thereby affecting sprouting percentage of seeds (Cheng-cang & Fa-shui, 1998). The pH values of four treatments were in the suitable range (5.3-7.0) of main crops growing in media, in contrast, S1 (100% humus soils with dung of Hepialidae Laravae) with pH value of 5.3 was the best nursery media for sprouting percentage.

3.3 The Influence of Nursery Substrates on Shape of *F. cirrhosa* Bulbs

Bulbs *Fritillaria cirrhosa* were divided into three groups (Chinese Pharmacopeia, 1980): 'Song Bei' (longitudinal dia. 0.13~0.18 cm, transverse dia. 0.13~0.19 cm), 'Qing Bei' (longitudinal dia. 0.14~1.14 cm, transverse dia. 0.14~1.16 cm) and 'Lu Bei' (longitudinal dia. 0.17~2.15 cm, transverse dia. 0.17~2.15 cm).

Therefore, the R of Bulbuls *Fritillaria cirrhosa* was 0.95~1.13. R could directly express the appearance of Chinese herbal medicines, in addition, R was used as the index for commercial evaluation for controlling the appearance quality standards of Bulbuls *Fritillaria cirrhosa* (Jun et al., 2009). So if R of Bulbuls *Fritillaria cirrhosa* were in this range (0.95~1.13), the shape of bulbs was regarded as good. Transverse diameter represents the size of bulbs in the traditional commercial market of Bulbuls *Fritillaria cirrhosa*. In this test, the influence of nursery substrates on shape of *F. cirrhosa* one-year-old and two-year-old bulbs were showed in Table 6 and Table 7, respectively. The correlation analyses of the shape of *F. cirrhosa* with BD and Hydrolysable N were showed in Table 8.

3.3.1 One-Year-Old Bulbs

The study revealed that SS1 achieved average of transverse dia. (4.17 mm) —this was significantly more than the other treatments in the test. It indicated that S1 (100% humus soils with dung of Hepialidae Larvae) was the best medium for promoting the seedlings and getting the large size of bulbs. Viewed the SS4, it achieved average of longitudinal dia. —this was significantly less than the other treatments, but it achieved average of transverse dia. —this was just significantly less than SS1 and was no significant difference with the others in the test. It indicated that S4 (100% sandy soil) could inhibit the growth of bulbs, getting the better shape of bulbs. In addition to SS4, R (the ratio of longitudinal dia. to transverse dia.) of the other treatments were not in the range of 0.95~1.13. It explained that the growth of bulbs' longitudinal dia. were greater than the growth of bulbs' transverse dia. in SS1, SS2 and SS3. R of SS4 was significantly less than others and the transverse dia. of SS4 was the least.

3.3.2 Two-Year-Old Bulbs

SB1 (6.05 mm) and SB2 (5.77 mm) had no significant difference with each other in average of transverse dia., but both were significantly larger than SB3 and SB4. It indicated that S1 (100% humus soils with dung of Hepialidae Larvae) and S2 (100% humus soils) were advantageous for the growth of plantlet bulbing and getting the large size of bulbs. SB3 (6.05 mm) and SB4 (5.77 mm) had no significant difference with each other in average of transverse dia. and longitudinal dia., but both were significantly less than SB1 and SB2. It indicated that adding sandy soil to substrates or 100% sandy soil as nursery media could inhibit the growth of bulbs, getting the better shape of bulbs. R of all treatments were not in the range of 0.95~1.13. It explained that the growth of bulbs' longitudinal dia. were greater than the growth of bulbs' transverse dia. in all media. The R and transverse dia. of SB3 and SB4 were both significantly less than SB1 and SB2.

3.3.3 Correlation Analysis of the Shape of *F. cirrhosa* with BD and Hydrolysable N

BD had significant negative correlation at the 0.05 level with R of *F. cirrhosa* one-year-old bulbs and two-year-old bulbs with correlation coefficient of 0.968 and 0.960. It explained that BD had significant influence on R of *F. cirrhosa* one-year-old bulbs and two-year-old bulbs. Hydrolysable N had significant positive correlation at the 0.05 level with R of *F. cirrhosa* one-year-old bulbs and two-year-old bulbs with correlation coefficient of 0.954 and 0.956. It explained that Hydrolysable N had significant influence on R of *F. cirrhosa* one-year-old bulbs and two-year-old bulbs.

3.4 The Influence of Nursery Substrates on Biomass of *F. cirrhosa* Bulbs

In production, the same weight of bulbs was consistent with their nutrient content (Jun et al., 2009). Therefore, when the amount of bulbs was same, the heavier weight of bulb was, the more nutrient content of bulbs contained.

3.4.1 One-Year-Old Bulbs

The study revealed that SS1 achieved 30-grain fresh weight (1.25 g) and 30-grain dryweight (0.2923 g) —this was significantly more than the other treatments in the test. It explained that S1 (100% humus soils with dung of Hepialidae Larvae) was advantageous for the seeding growth and getting the large size of bulbs. The bulbs were dried at 1,859°F to a constant mass for 48 h. The moisture rates of all treatments had no significant difference with each other. The mean value of moisture rates of SS1, SS2, SS3 and SS4 were 76.58%, 74.16%, 74.98% and 74.30%, respectively.

3.4.2 Two-Year-Old Bulbs

Viewed 30-grain fresh weight and 30-grain dry weight, both SB1 and SB2 were significantly more than SB3 and SB4. The 30-grain fresh weight of SB1 and SB2 were 5.15 g and 4.29 g, respectively. The 30-grain dry weight of SB1 and SB2 were 1.3058 g and 1.8750 g, respectively. It indicated that S1 (100% humus soils with dung of Hepialidae Larvae) and S2 (100% humus soils) were advantageous for the growth of plantlet bulbing and

getting larger size of bulbs. SB3 (72.73%) and SB2 (71.61%) had no significantly difference with each other in moisture rate, but both were significantly less than SB3 and SB4. It indicated that bulbs contained relatively less free water, which was plant with adding sandy soil to substrates or 100% sandy soil.

4. Discussion

Considered the result of media nutrients content in this test (Table 3) and the classification of the soil nutrient status of second soil investigation in China (1992, Table 11), the study showed that the classifications of the available nutrient of S1, S2, S3 and S4 were grade 1, grade 2, grade 3 and grade 6, respectively. Consequently, the media of better available nutrient were S1 and S2, and the medium of the poor available nutrient was S4. Studied dry weight of bulbs, SS1 was significantly more than the other treatments, and both SB1 and SB2 were significantly more than SB3 and SB4. According to the survey, *F. cirrhosa* seedlings could be stored on S4 which contained the poorly available nutrient. It explained that seedling growth possibly needed fewer nutrients. S1 was made of humus soils with dung of *Hepialidae* Laravae. Dung was one of agricultural wastes. Carlisle and Wilson (1991) considered that the main direction of choosing media was taken full advantage of the agricultural wastes and realized resources reusable utilization. In this test, S1 (100% humus soils with dung of *Hepialidae* Laravae) achieved dry weight of one-year-old and two-year-old bulbs –these were significantly more than the other media. It inferred that the excretion of *Hepialidae* Laravae contained physiological active substance except N, P, and K, which were played an important role on enhancing dry weight of bulbs. Currently, the physiological active substance of Vermicompost had been studied (Albanell et al., 1998).

Based on field investigation of cultivating Bulbs *Fritillariae cirrhosae*, predecessors and author found that bulbs had been obviously produced, but the reasons of produced bulbs were unclear. There were only data for one year, besides the test of single factor was absent. So the causes of produced Bulbs *Fritillariae cirrhosae* bulbs were not explicated by the results of this test. If combining the results of this test with the causes of tuberization by predecessors studying, the reasons of produced Bulbs *Fritillariae cirrhosae* bulbs were several possible explanations as followings:

Firstly, plant cell division and produced growth of plant cell were sensitive to water. Plant growth needed a certain degree of turgor pressure. Shortage of water would make turgor pressure reduce or even disappear, and it seriously affected cell division and cell produced growth to inhibit the growth of plants (He-sheng, 2002). The main condition which made produced growth of cell was water.

Cell water potential deficiency formula: $\Delta\varphi = \varphi_0 - \varphi_w$

In the expressions, φ_0 : environmental water potential, φ_w : cell water potential.

Water of environment would automatically enter from extracellular to intracellular ($\Delta\varphi > 0$)-protoplast expanded-promoted turgor pressure-expanded primary cell wall-produced growth of cell (Ji-shu, 1999). In this test, Bulbs *Fritillariae cirrhosae* bulbs were in media environment. Consequently, the unsuitable management measures probably made media contain too much water. Meanwhile based on field investigation of cultivating Bulbs *Fritillariae cirrhosae* by author, the produced Bulbs *Fritillariae cirrhosae* bulbs were found in soil with shortage of water. It inferred cell produced growth of Bulbs *Fritillariae cirrhosae* bulbs were sensitive to shortage of water. This phenomenon was supported by the findings of He-sheng (National Soil Survey Office, 2002) that shortage of water hardly affect produced growth of roots-growing areas. To sum up the above arguments, the morphogenesis of Bulbs *Fritillariae cirrhosae* bulbs was stuck in water of media, and this result was used for reference for suitable management measures of Bulbs *Fritillariae cirrhosae*.

Secondly, N was contained in stems and leaves in the prophase and metaphase of growth of crops (He-sheng, 2002). Therefore, N could promote division and growth of stems. The bulb of Bulbs *Fritillariae cirrhosae* was a kind of modified subterranean stems. In this test, Hydrolysable N had significant positive correlation at the 0.05 level with R of *F. cirrhosa* one-year-old bulbs and two-year-old bulbs with correlation coefficient of 0.954 and 0.956. The total N of S1, S2 and S3 (1.061%, 1.530%, 0.865%, respectively) and the hydrolysable N of S1, S2 and S3 (599 mg/kg, 673 mg/kg, 374 mg/kg, respectively) were higher than the nutrients level of general soils. To sum up the above arguments, one of causes of produced Bulbs *Fritillariae cirrhosae* bulbs was probable nursery media contained higher nutrient (N). This inference was supported the findings of Hui-jun et al. (2006) and Yuan et al. (2012) that nitrogen supplying had impact on produced growth of several crops stems.

Thirdly, harvested organ was the underground parts of crops such as sweet potato and the findings of Kazuyuki and Toshio (1964, 1965) were that increasing the soil bulk density would stunt sweet potato roots swelled. In this test, media bulk density had significant negative correlation at the 0.05 level with R of *F. cirrhosa* one-year-old bulbs and two-year-old bulbs with correlation coefficient of 0.968 and 0.960. Therefore,

media bulk density was probable one of the cause of the growth of bulbs' transverse dia. less than the growth of bulbs' longitudinal diameter.

Table 1. Definition of bulbs in *F. cirrhosa*

Bulbs	Definition
Longitudinal dia.	From tip of bulbs to growing points of bulbs' roots
Transverse dia.	Be perpendicular to longitudinal diameter
R	The ratio of longitudinal diameter to transverse dia.
One-year-old bulbs	Sow with seeds and reap bulbs after 'sprout tumble' in the same year
Two-year-old bulbs	Sow with one-year-old bulbs and reap bulbs after 'sprout tumble' in the same year

Table 2. Physical character of media

nursery media	BD (g/cm ³)	TP/%	AP/%	WRP/%
S1	0.617	63.22	21.10	42.12
S2	0.693	46.89	25.48	21.41
S3	1.105	46.79	31.88	14.91
S4	1.617	33.51	30.01	3.50

Note: BD=Bulk Density, TP=Total Porosity, AP=Aeration Porosity, WRP= Water Retaining Porosity.

Table 3. Chemical character of media

nursery media	S1	S2	S3	S4
pH	5.3	6.3	6.4	6.5
CEC	48.5	71.9	39.2	4.1
Organic matter/%	26.98	38.34	21.46	4.15
Total N/%	1.061	1.530	0.865	0.092
Total P/%	0.177	0.128	0.066	0.027
Total K/%	1.680	1.070	0.538	0.073
Hydrolysable N (mg/kg)	599	673	374	74
Available P (mg/kg)	97.6	29.6	14.8	4.4
Available K (mg/kg)	684	309	155	14

Note: CEC=Cation Exchange Capacity.

Table 4. The influence of nursery substrates on the germination rate of *F. cirrhosa* bulbs

Treatments	sowing with seeds/%	Treatments	sowing with one-year bulbs /%
SS1	63.25±3.0703a	SB1	91.30±2.2433a
SS2	52.23±2.1121b	SB2	83.36±1.1147b
SS3	50.20±3.1532b	SB3	85.28±0.9921b
SS4	48.40±2.0502c	SB4	83.30±2.4714b

Mean values followed by the same letter are not significant difference at $p \leq 0.05$.

Table 5. Correlation analyses of pH and sprouting percentage of *F. cirrhosa*

	sowing with seeds	sowing with one-year bulbs
pH	-0.966**	-0.960*

* express significant correlation ($P=0.05$), ** express high significant correlation ($P=0.01$).

Table 6. The influence of nursery media on shape of *F.cirrrosa* one-year bulbs ($\bar{x}\pm s$, n=90)

Treatments	Longitudinal dia. (mm)	Transverse dia.(mm)	R
SS1	5.28±0.3205a	4.17±0.1443a	1.27±0.0322a
SS2	4.68±0.1722b	3.70±0.1952b	1.26±0.0322a
SS3	4.70±0.3109b	3.84±0.0917b	1.23±0.0551a
SS4	3.39±0.0603c	3.76±0.1212b	1.11±0.1277b

Mean value followed by the same letter are not significant difference at $p\leq 0.05$.

R=the ratio of longitudinal dia. to transverse dia.

Table 7. The influence of nursery media on shape of *F. cirrhosa* two-year bulbs ($\bar{x}\pm s$, n=90)

Treatments	Longitudinal dia.(mm)	Transverse dia.(mm)	R
SB1	9.78±0.2325a	6.05±0.1342a	1.63±0.2573a
SB2	9.32±0.2369a	5.77±0.1114a	1.63±0.2904a
SB3	8.14±0.1893b	5.27±0.1005b	1.54±0.2450b
SB4	7.88±0.1860b	5.17±0.1088b	1.51±0.2844b

Mean value followed by the same letter are not significant difference at $p\leq 0.05$.

R=the ratio of longitudinal dia. to transverse dia.

Table 8. Correlation analyses of the shape of *F.cirrrosa* with BD and Hydrolysable N

	one-year-old bulbs			two-year-old bulbs		
	Longitudinal dia.	Transverse dia.	R	Longitudinal dia.	Transverse dia.	R
BD	-0.926	-0.463	-0.968*	-0.929	-0.912	-0.960*
Hydrolysable N	0.868	0.297	0.954*	0.888	0.859	0.956*

* express significant correlation ($P=0.05$), ** express high significant correlation ($P=0.01$).

R=the ratio of longitudinal dia. to transverse dia.

Table 9. The influence of nursery substrates on biomass of *F. cirrhosa* one-year bulbs ($\bar{x}\pm s$, n=3)

Treatments	30-grain fresh weight (g)	30-grain dry weight (g)	moisture rate (100%)
SS1	1.25±0.0924a	0.2923±0.0405a	76.58±3.8741a
SS2	0.85±0.0577b	0.2198±0.0123b	74.16±2.3155a
SS3	0.94±0.0982b	0.2334±0.0186b	74.98±2.2352a
SS4	0.62±0.0231c	0.1596±0.0081c	74.30±1.9600a

Mean values followed by the same letter are not significant difference at $p\leq 0.05$.

Table 10. The influence of nursery substrates on biomass of *F.cirrrosa* two-year bulbs ($\bar{x}\pm s$, n=3)

Treatments	30-grain fresh weight (g)	30-grain dry weight (g)	moisture rate (100%)
SS1	5.15±1.2939a	1.3058±0.3291a	74.64±1.0579a
SS2	4.29±0.5910a	1.0879±0.1696a	74.68±0.4729a
SS3	2.88±0.5484b	0.7854±0.1337b	72.73±0.7300b
SS4	2.59±0.2921b	0.7373±0.1105b	71.61±1.5478b

Mean values followed by the same letter are not significant difference at $p\leq 0.05$.

Table 11. The classification of the soil nutrient status of second soil investigation in China

Grade	1	2	3	4	5	6
Organic matter/%	>4	3-4	2-3	1-2	0.6-1	<0.6
Total N/%	>0.2	0.15-0.2	0.1-0.15	0.075-0.1	0.05-0.075	<0.05
Hydrolysable N(mg/kg) NN(mg/kg)	>150	120-150	90-120	60-90	30-60	<30
Available P(mg/kg)	>40	20-40	10-20	5-10	3-5	<3
Available K(mg/kg)	>200	150-200	100-150	50-100	30-50	<30

Note: the worse the quality of soil, the greater grade number.

5. Conclusion

Under the nursery mode of shed at Plateau, Sowing with seeds and one-year-old bulbs of *F. cirrhosa*, S1 (100% humus soils with dung of Hepialidae larvae) was the best nursery media for sprouting.

The integrated performance was considered, including transverse diameter, longitudinal diameter, the ratio of longitudinal diameter to transverse diameter, 30-grain fresh weight and 30-grain dry weight. Under the nursery mode of shed at Plateau, sowing with *F. cirrhosa* seeds, S1 (100% humus soils with dung of Hepialidae Larvae) was the best medium for promoting the seedlings and getting larger size of bulbs. Under the nursery mode of shed at Plateau, sowing with one-year-old *F. cirrhosa* bulbs, S1 (100% humus soils with dung of Hepialidae Larvae) and S2 (100% humus soils) were advantageous for the growth of plantlet bulbing and getting larger size of bulbs.

References

- Albanell, E., Plaixas, J., & Cabreo, T. (1988). Chemical changes during Vermicomposting (*Elena fetid*) of sheep manure mixed with cotton industrial wastes. *Biology and Fertility of Soils*, (6), 266-269.
- Canuto, K. M., Silveira, E. R., Bezerra, A. M. E., Leal, L. K., & Viana, G. S. B. (2012). Phytochemistry, Pharmacology and Agronomy of Medicinal Plants: Amburana cearensis, an Interdisciplinary Study. *Phytochemicals-A Global Perspective of Their Role in Nutrition and Health*, 354-374.
- Carlisle, W. R., & Wilson, D. P. (1991). Microbicom acting in growly media a brief review. *Acta-hort*, 294, 187-206.
- Cheng-cang, M., & Fa-shui, H. (1998). Effect of PH on Seed Germination and Seedlings Growth and Metabolism in Rape. *Acta Agronomica Sinica*, 24(4), 510-512.
- Chinese Pharmacopoeia Commission. (2010). *Pharmacopoeia of the People's Republic of China (Chinese Pharmacopoeia)*, China: China Medical science press.
- Cong, W., Shu, W., & Jing, M. (2010). HPLC Fingerprint of Bulbus *Fritillariae cirrhosae*. *West China Journal of Pharmaceutical Sciences*, 25(1), 061-063.
- Da-yong, Z., Shu, W., Qing, L., Zhen-dong, L., & Cong, W. (2010). The study of the optimum harvesting year for *F. wabuensis*. *West China Journal of Pharmaceutical Sciences*, 25(6), 725-726.
- Editorial Committee of Chinese Academy of Sciences (Flora of China). (1980). *Flora of China* (Vol. 14, p. 104). Beijing: Science Press.
- Guang-song, L. (Eds.) (1996). *Soil physical and chemical analysis and description of soil profiles* (p. 104). Beijing: China Standard Press.
- He-sheng, L. (Eds.) (2002). *Modern Plant Physiology* (pp. 147, 301, 307). Higher Education Press.
- Hui, L., Shi-lin, C., Hui, Y., Xi-wen, L., & Yi, Z. (2008). Research progress on resources in Bulbus *Fritillariae cirrhosae*. *China Journal of Chinese Materia Medica*, 33(14), 1645-1648.
- Hui-jun, Z., Yi-ping, X., Chun-hui, H., & Ming-liang, C. (2006). Studies on bulblet development and carbohydrates metabolism in bulbs of *Lilium* Oriental hybrids grown in mountainous region. *Journal of Zhejiang University*, 32(5), 535-540.
- Ji-shu, Z. (Eds.) (1999). *Plant Physiology* (p. 266). Xi'an: World Book Publications.
- Jun, Z., Meng, Y., Sun-cai, Z., Yong, D., & Li, X. (2009). Study on the classification of artificial cultivation of *Fritillaria* Bulb harvest. *Chin Tradit Herb Drugs*, 40, 273-276.

- Kazuyuki, W., & Toshio, K. (1964). Effects of capacity and composition of soil air on the growth and yield of sweet potato plants. *Japan Jour Crop Sci*, 33(4), 418-422.
- Kazuyuki, W., & Toshio, K. (1965). Effects of the different soil structures on a few physiological characters of sweet potato plants. *Japan Jour Crop Sci*, 34(4), 409-412.
- Kssica, A. F. (1997). Something to grown on Cornell cooperative Extension. *Department of Floriculture and Ornamental Horticulture Cornell University, Ithaca, N Y*. Retrieved July 25, 2001 from <http://www.cals.cornell.edu/dept/flori/growon/media/porosity.html>
- Li-hong, G. (2004). The Physicochemical Characteristics and Species of Media in Soilless Culture. *Applied Engineering Technology in Rural Areas*, 2(6), 28-30.
- National Soil Survey Office. (1992). *The Technology of national soil survey of China*. Beijing: Agricultural Press.
- Rao-sheng, C. (2010). Effect of Kinds of Different Matrix and Their Formula on Seedling Growth of *Atractylodes macrocephala* Koidz. *Journal of Anhui Agri. Sci*, 38(34), 19319-19320, 19324.
- Rao-sheng, C. (2011). Application of mushroom residue in *Carthamus tinctorius* L. seeding. *Jiangsu Agricultural Sciences*, 39(5), 348-349.
- Ru-kun, L. (Eds.) (1999). *The analysis methods of Soil Agricultural Chemistry* (pp. 269-271). Beijing: China Agricultural Science and Technology Press.
- Shi-lin, C., Xiao-he, X., & Shan-Yong, C. (1990). Study on relationship between *Fritillaria unibracteata* Hsiao et K.C.Hsia quality and soil ecology. *Journal of Chinese Medicinal Materials*, 13, 3-5.
- Shi-zhe, L. (Eds.) (2001). *Modern Soilless Cultivation Techniques* (pp. 147-172). Beijing: China Agriculture Press.
- Sonneled, C. (1991). Rockwool as substrate for greenhouse crops. *Biotechnology in Agriculture and Forestry*, (17), 285-312. http://dx.doi.org/10.1007/978-3-642-76415-8_17
- Srivastava, J., Lambert, J., & Vietmeyer, N. (1996). *Medicinal Plants: An Expanding Role in Development*. Washington DC: World Bank Publications. <http://dx.doi.org/10.1596/0-8213-3613-4>
- WHO (The World Health Organization), IUCN (The World Conservation Union) & WWF (World Wide Fund for Nature). (1993). *Guidelines on the Conservation of Medicinal Plants*. Geneva, Switzerland.
- Wilson, D. P., & Carlisle, W. R. (1991). Storage properties of peat beset. *Acta-hort*, 294, 13-23.
- Xiao-yan, Y., Xian-ming, M., Hong-tao, X., & Zheng-Ji, M. (2009). Effect of 3 kinds of *Bullbus Fritillariae cirrhosae* on respiratory dynamics of asthmatic guinea pig. *China Journal of Chinese Materia Medica*, 34(20), 2656-2659.
- Ying-ying, H. (2008). Study on the characteristics of seed germination and cultivation technology of *Fritillaria cirrhosa*. Master Thesis, *Sichuan Agricultural University*, Sichuan, China.
- Yuan, G., Yong-lin, Q., & Ming-shou, F. (2012). Potato Tuber Forming and Growth Influenced by Nitrogen. *The Crop Journal*, 6, 14-18.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>).