

## Annual Distribution of Microelements in Dragon Fruit Production System in Dry-hot Valley of the Yuanjiang River

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**Abstract:** In this paper, soil microelements are detected from different dragon fruit planting plots in the dam and mountain areas of dry-hot valley of the Yuanjiang River. Then, the nutrient requirements of dragon fruit plants are analyzed combined with the annual biomasses of branches and fruits. The results show that during the process of cultivating dragon fruits, the amounts of annual nutrient input are pure boron 30kg/ha, pure magnesium 150kg/ha, zinc sulfate 45kg/ha, manganese sulphate 30kg/ha and ferrous sulphate 30kg/ha; the contents of available boron are low in dragon fruit planting plots in dry-hot valley of the Yuanjiang River; the exchangeable calcium contents are between grade 1 and 3; the differences in exchangeable calcium contents are great, with highest level reaching grade 2; the contents of exchangeable magnesium fluctuate greatly between grade 1 and grade 5; the contents of water soluble chloride are between grade 2 and grade 4; the contents of hydrolytic available nitrogen are between grade 2 and grade 5; the contents of available copper are between grade 1 and grade 4; the contents of available zinc are above grade 2. In general, the contents of available boron, exchangeable magnesium, water-soluble chloride, available copper, available zinc, available iron and available manganese are relatively low. In the process of dragon fruit cultivation, nutrients with different microelements should be applied in time to ensure the nutrient requirements of dragon fruit plants.

### 1. Introduction

Dragon fruits, also known as pitayas, are the fruits of several cultivated varieties of the genus *Hylocereus undatus* and the genus *Selenierys* from the plant family Cactaceae; they are the fruits of perennial climbing cacti with characteristics of strong vitality and adaptability, as well as less plant diseases and insect pests. [1] Dragon fruits are indigenous to tropical deserts in Central America; they distribute in tropical America, West Indies and other tropical regions. [2] In addition to large-scale cultivation in tropical and subtropical regions of South America, they are also widely cultivated in tropical Asian countries like Vietnam, Kampuchea, Thailand and Malaysia.[3] In Taiwan, dragon fruits were first introduced by the Dutch as ornamental plants in the early Twentieth Century; in 1930s, they were cultivated in large scale as commercial fruits.[4] Guangdong, Guangxi, Hainan and Fujian transplanted dragon fruit cacti from Taiwan and began to cultivate them in large scale; now these provinces have established many large-scale dragon fruit farms and become important producers of commodity dragon fruits. In the northern part of China, dragon fruits can also be cultivated as long as warming apparatus and heating measures are increased. [5] Dragon fruit cacti can produce fruits, flowers, vegetables, medicine and health care products; they have high economic value. In addition to selling fresh fruits, non commodity dragon fruits can be processed to jam, fruit wine, dried fruits and a series of related products. The pulps and peels can be used to extract natural pigments of anthocyanin and beet red. The stems and flowers also have development value. Cacti stems can be eaten as vegetables, or processed to become additives in animal food; flowers can be stored or sold as fresh vegetables or frozen dried vegetables. The industrial chain can be extended. [6]

At the same time, dragon fruit cacti can grow in dry, barren environment, and need a large quantity of calcium. Suitable ecological areas include poor, mountainous areas, key desertification control areas and areas with special climate conditions. Yunnan has relatively serious stony desertification; dragon fruits are ideal plants which can adjust the planting structure of rocky desertification areas in low altitude mountains. Therefore, the cultivation of dragon fruits and the development related industries can be combined with projects of ecological management, farmers' income increasing and tourism to promote the effective development of other industries and the regional economy. [7] Dragon fruit cacti are tropical and subtropical plants. They like sunshine and fertile soil, but tolerant to shade, dry, hot environment and barren soil. They have strict requirements on climate conditions, which lead to the limited planting area and continuous growing market demands. The cultivation history of dragon fruit is short in China. At present, they are planted in very limited areas in Taiwan, Hainan, Guangxi, Guangdong, Fujian and other regions. In the northern area, they are planted in greenhouses in a small scale. But in other provinces and regions, cultivated lands have already been occupied by other tropical economic crops. The development of dragon fruit industry in China is still in the primary stage. With the rapid development of ecological manor economy of China, the future of dragon fruit industry will be better. [8] According to incomplete statistics, except for Taiwan, in 2012, the national dragon fruit planting area was only about 120 thousand ha. In recent years, although the planting area has been expanded, the market gap is still huge; the price of dragon fruit is increasing year by year. [9] At present, with the growing of dragon fruit planting area and the continuous expansion of market demand, dragon fruit cultivation and management are still in the period of extensive development. In Yunnan, the phenomena of scattered planting areas, small farm scales, high management cost and lack of technical standards are particularly prominent. Therefore, it is necessary to analyze the distribution of soil nutrients and the nutrient requirements of different organs in dragon fruit cacti, in order to provide scientific basis for future research on the precise, differentiated nutrient management system in dragon fruit cultivation, and weaken the potential risks of non point source pollution caused by irrational fertilization.

## **2. Research Materials and Methods**

### **2.1 Sampling method**

The sampling location was the planting base of Yunan Agricultural Science and Technology Company of Yunnan Province; the planting base covered about 1000ha. Samples were taken from mountainous area (No. 3 and 8 No. bases with the elevation of 500-800m) and dam area (bases of No.11, No.12, No.14 and No.15 with the elevation of 400-500m). Among them, the terrain and elevation differences of No. 3 base were small; one multi-point mixed sample was taken. The elevation difference of No. 8 base was large; three multi-point mixed samples were taken. The area of No. 11 base was large; three multi-point mixed samples were taken. For other bases, one sample was taken from each of them. The samples were taken from the depth of 0-30cm, then mixed and dried by air. The branches of dragon fruit cacti in different growth periods (0.5-1 year old, 1-2 years old, 3-5 years old) were selected from No. 3, No. 8, No. 11, No. 12, No. 14 and No. 15 bases and tested for mixed samples.

### **2.2 Detection method**

The samples were collected and tested by the Testing and Analysis Center of Yunnan Academy of Agricultural Sciences to determine the contents of water soluble chloride ion (NY/T1378-2007), the contents of available boron (NY/T1121.8-2006), the contents of exchangeable calcium and magnesium (NY/T1121.13-2006), and the contents of available zinc, manganese, iron and copper in soil (NY/T890-2004).

### 3. Research Results and Analysis

#### 3.1 Background of soil nutrients

In the annual production cycle of dragon fruits in dry-hot valley of the Yuanjiang River, characteristics of microelement distribution in soil include (Table 1): according to the National Classification Standards for the Second General Survey of Soil, the contents of available boron in soil were low ( $< 0.5\text{mg/kg}$ ); the contents of exchangeable calcium varied greatly between grade 1 and grade 3 ( $>800\text{mg/kg}$ ) with the higher level reached grade 2 ( $7418.83\text{-}9232.07\text{mg/kg}$ ). Since No. 8 base was newly reclaimed mountain area, the exchangeable calcium content was low in grade 6 ( $<823.31\text{mg/kg}$ ). Generally speaking, the contents of exchangeable magnesium fluctuated greatly between grade 1 ( $>188\text{mg/kg}$ ) and grade 5 ( $< 626.71\text{mg/kg}$ ). No. 3 and 8 bases were newly reclaimed lands and had low exchangeable magnesium contents. Water soluble chloride ion contents were between grade 2 ( $20\text{-}25\text{g/kg}$ ) and grade 4 ( $10\text{-}15\text{g/kg}$ ), showing a more uniform distribution of potassium. The contents of hydrolytic available nitrogen were between grade 2 ( $0\text{-}4.37\text{mg/kg}$ ) and grade 5 ( $30\text{-}43.82\text{mg/kg}$ ) with great differences; the contents of available copper were between grade 1 ( $>0.63\text{mg/kg}$ ) and grade 4 ( $1.33\text{-}4.02\text{mg/kg}$ ). The available copper contents of the newly reclaimed mountain areas (No. 3 and No. 8 bases) were relatively low. The contents of available zinc were relatively high and above the level of grade 2 ( $2.34\text{-}8.02\text{mg/kg}$ ). But the total amounts of microelements were relatively low, with the available iron contents between  $5.14\text{-}50.23\text{mg/kg}$  and available manganese contents between  $4.85\text{-}17.77\text{mg/kg}$ . The distribution of microelements was mainly characterized by high exchangeable calcium content, and low contents of available boron, exchangeable magnesium, water-soluble chloride ions, available copper, available zinc, available iron and available manganese. In the process of dragon fruit cultivation, nutrients with different microelements should be applied in time to ensure the nutrient requirements of dragon fruit plants.

Table 1 Contents of microelements in soil of different bases

site	available boron mg/kg	exchangeable calcium mg/kg	exchangeable magnesium mg/kg	water soluble chloride ion mg/kg	available copper mg/kg	available zinc mg/kg	available iron mg/kg	available manganese mg/kg
No. 3 base	0.08	7418.83	176.15	10.45	1.28	0.74	5.15	8.87
No. 8 base	0.06	1430.65	626.71	0.00	0.63	0.76	19.16	5.33
No. 8 base	0.05	823.31	424.51	22.15	0.58	0.62	10.80	9.00
No. 8 base	0.08	9232.07	303.22	12.79	1.33	1.10	6.03	5.56
No. 11 base	0.30	6351.05	392.11	43.82	2.32	1.41	10.32	8.06
No. 11 base	0.29	5904.19	394.50	43.04	3.03	2.15	11.87	6.14
No. 11 base	0.33	5804.45	318.17	8.42	3.55	2.34	7.38	7.06
No. 12 base	0.32	6338.14	301.05	15.75	4.02	8.02	5.14	17.77
No. 14 base	0.30	3118.05	188.00	4.37	1.68	1.79	13.76	4.85
No. 15 base	0.14	2310.89	464.22	36.49	2.45	1.23	50.23	6.78

Table 2. Contents of nutrients uptake by branches of dragon fruit cacti per year

sampling location	biomass of the plant kg/ha	Uptake of boron kg/ha-per year	Uptake of sulphur kg/ha-per year	Uptake of calcium kg/ha-per year	Uptake of magnesium kg/ha-per year	Uptake of copper kg/ha-per year	Uptake of zinc kg/ha-per year	Uptake of iron kg/ha-per year
No. 3 base	75000.00	2463.00	8.25	144.75	51.75	66.00	1909.50	4074.00
No. 8 base	75000.00	1635.00	9.00	158.25	58.50	273.00	2070.00	4907.25
No. 11 base	75000.00	2699.25	9.75	270.00	60.75	27.75	1787.25	4836.75
No. 12 base	75000.00	2472.00	13.50	329.25	63.75	28.50	2633.25	3747.00
No. 14 base	75000.00	2151.00	18.75	334.50	53.25	30.00	1380.00	4170.00
No. 15 base	75000.00	761.25	16.50	245.25	74.25	37.5	2411.25	3171.75

### 3.2 Contents of nutrients uptake by branches and fruits of dragon fruit cacti per year

The amount of boron uptake by branches of dragon fruit cacti in each hectare reached 761.25-2699.25kg (Table 2); the amount of sulfur reached 8.25-18.75kg; the amount of calcium reached 144.75-334.5kg; the amount of magnesium reached 51.75-74.25kg; the amount of copper reached to 27.75-273.00kg; the amount of zinc reached 1380.00-2633.25kg; the amount of iron reached 3171.75-4907.25kg. These figures reflected the low levels of absorption and utilization, and showed that dragon fruits were able to tolerate poor nutrients environment. From table 3 it could be seen, the amounts of lead, cadmium, chromium, copper, arsenic and mercury in dragon fruits per hectare were between 5.85kg to 8.10kg, between 9.23 kg to 22.05kg, between 0.00 kg to 0.68kg, between 18.23 kg to 24.75kg, between 0.01 kg to 0.02kg and between 0.02 kg to 0.05kg respectively.

Table 3. Contents of nutrients uptake by fruits of dragon fruit cacti per year

samples	Yield Kg/ha-Per year	Lead content kg/per year	cadmium content kg/per year	chrome content kg/per year	copper content kg/per year	Arsenic content kg/per year	mercury content kg/per year
Small fruit	22500.00	5.85	9.23	0.00	22.50	0.02	0.05
Medium fruit	22500.00	8.10	22.05	0.45	24.75	0.02	0.02
Big fruit	22500.00	7.20	15.53	0.68	18.23	0.01	0.05

## 4. Discussion

It was found that the distribution of microelements was mainly characterized by high contents of exchangeable calcium and low contents of available boron, exchangeable magnesium, water-soluble chloride, available copper, available zinc, available iron and available manganese. In addition, it could be seen from table 2 that the absorption and utilization of boron, sulfur, calcium, magnesium, copper, zinc and iron were at lower levels. These figures also showed that dragon fruits were able to tolerate poor nutrients environment

Dragon fruits are rich in Mg, Ca, Zn, Fe, Cu and other mineral elements. [10] Researches show that, calcium is the main component of sclerotin; it can enhance the density of capillary wall, reduce its permeability and reduce exudation; calcium also has effects of anti-inflammation, anti-swelling

and anti-histamine. [11] Magnesium can promote the metabolism of myocardium, prevent and alleviate hypertension, hyperlipidemia and arrhythmia, and reduce the occurrence of myocardial infarction. [12] Dragon fruits are rich in magnesium; they have been identified as a good fruit in lowering blood fat levels and blood pressure. As an important microelement which can boost immune function, zinc has positive effects on strengthening our body's defenses and preventing various diseases. [13] Copper and iron are also essential microelements for human body. They participate in hematopoiesis process, and serve as important components of hemoglobin in erythrocytes. They are activating agents in the synthesis of hemoglobin. In human body, iron is the component of various enzymes, as well as the component of hemoglobin and muscle hemoglobin in blood system. Iron deficiency can lead to iron deficiency anemia and hyperlipidemia. Copper also participates in hematopoiesis process; it promotes the absorption, transport and utilization of iron, promotes the conversion from inorganic iron to organic iron, and promotes the synthesis of hemoglobin porphyrin. Copper deficiency can lead to coronary heart disease, myocardial infarction, atherosclerosis and hypertension. It can be seen that copper and iron should be constantly supplemented from diet to promote hematopoiesis and blood circulation, so as to prevent and treat anemia. [14] Therefore, the various health functions of dragon fruits not only come from diversified nutrients, but also come from the high contents of various microelements.

Studying the circulation mechanism of microelements and its sustainability in farmland ecosystem is essential to agriculture, ecology and environment research. In dragon fruit cultivation system, resource endowment (the contents of microelements in farmland soil and the conditions of fertilizer application) should be taken as constraint conditions to find out the amounts of microelements uptake by the production system. This study provides a scientific basis for the management and control of microelements in dragon fruit cultivation system in hot-dry valley of the Yuanjiang River. A comprehensive nutrient management system should be established to effectively monitor the migration and transformation of microelements, in order to maximize the utilization of microelements, and provide reference for dragon fruit cultivation system and the sustainable development of agricultural economy.

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