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High-Quality Production of Food Plant

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ABSTRACT

With the increase of population and economic development of a country or a region, people consume more and more plant-based food. In order to meet increasing demand for the quantity and variety of food production, the most of the original forest has become food plants such as farmland, man-made forest, fruit, crop and grass. A lot of exotic food plant was introduced to produce food production. As plant grows, the plant resources relationship may change from equilibrium state to non-equilibrium state, which lead to land degradation, decline of vegetation and the decline of food yield and quality. In order to solve this problem, in this paper, saskatoon berries, red plum apricot and corn planted in semi-arid region of the Loess Plateau of China were taken as examples to study the plant resources relationship and the method of high-quality production of food plant. Saskatoon berries will grow well and fruit, but red plum apricot and corn cannot grow well and fruit. In order to realize the sustainable utilization of resources and the high-quality production of red plum apricot and corn, the limit of resources utilization by plants and vegetation carrying capacity, especially the vegetation carrying capacity in the key period of plant resources relationship regulation has to be applied to adjust the plant and resources relationship to obtain the maximum yield and benefit of food plant and realize high quality production of plant foods. SIGNIFICANCE In water-limited regions, the theory of resource utilization limit by plant is the soil water resources utilization limit by plants and the carrying capacity of vegetation is soil water carrying capacity for vegetation.

Keywords: Food Plant; High Quality Production; Sustainable Supply; Resources Utilization Limit by Food Plant; Vegetation Carrying Capacity

Key Points

1. With the increase of population and economic development of a country or a region, people consume more and more plant food.
2. To meet increasing demand for the quantity and variety of food production, it is better to obtain the maximum yield and benefit of food plant;
3. The limit of resources utilization by plants vegetation carrying capacity in the key period of plant resources relationship regulation must be used to carry out high-quality production of food plant.

Introduction

As the global population inches toward 10 billion and climate change threatens existing food security, Plant-based human food products are considered to be more sustainable than animal-derived products (Wehrmaker, et al. [1]). Food plants produce food and so on and provide a guarantee for people's health, life and development because some food, fruits and vegetables were negatively associated with the incidence of colon cancer (Leenders, et al. [2]) and positively related with health. For example, Citrus fruits are important health promoting fruits rich in bioactive components like limonoids, hesperetin, naringenin and citrus pectin. The anticancer properties were correlate with antioxidant enzyme rejuvenation, signaling pathway inhibition, inflammatory mediator suppression and cell cycle arrest

(Kaur [3]). Citrus fruits (CFs) containing flavanones exerted their antioxidant activity mainly by directly scavenging free radicals and enhancing the defense ability of cells (Singh & Kaur [4]). Grains and cereals are primary energy resources for human beings. Certain grains and cereals showed protective effects against colon cancer cells. Millet is an important cereal food and exhibits multiple biological activities, including immunomodulatory and antioxidant activities. A novel protein extracted from foxtail millet bran displayed anti-carcinogenic characteristics (Shan, et al. [5]). In addition, millet branderived bound polyphenols showed anti-inflammatory effects in LPS-induced HT-29 colon cancer cells via ROS/miR-149/Akt/NF-κB signaling pathway, indicating that the polyphenols might inhibit the initiation and progression of colorectal cancer (Shi, et al. [6]).

With the increase of population and economic development of a country or a region, people consume more and more plant-based food, there is an increasing demand for the quantity and variety of plant-based food production, but original forest ecosystem products and services cannot meet the need of demand for the quantity and variety of plant-based food production, most of the original forest has become food plants, farmland, man-made forest and grass (Guo and Shao [7]). A lot of exotic food plant was introduced to produce food and meet the need of the people. Because exotic food plant changes the plant resources relationship and the weather change with year and month in a year, which will cause vegetation decline or resources waste, which is not good for sustainable use of nature resources and high-quality produce of food plant. In order to solve these problems, we study the plant resources relationship and search the method for sustainable use of nature resources and high- quality produce of food plant.

Method and Material

Study site The study site located in the Shanghuang Eco-experimental Station, which belong to the semi-arid region of the Loess Plateau, in the Eastern 20 Km from Guyuan County, China, see (Figure 1). The area was located in a hilly loess region with an elevation range of 1,534 to 1,824 m and slope gradients of 0˚ to 10˚ and the slope gradients below the valley shoulder line is more than 25˚. The main soil type is Huangmian soil (Calcaric Cambisol, FAO 1988) that is developed from loess and is susceptible to soil and water losses, which are serious in this region. The rainfall is unevenly distributed in the year with a mean annual precipitation of 416 mm, and rainfall from June to September accounts for 64.7 % of the total annual precipitation. The coefficient of variation of precipitation among the years from 1983 to 2001 was 23.8% and rainfall amounts ranged from 259.9 mm in 1991 to 634.7 mm in 1984, with a median rainfall amount of 434 mm, see (Figure 2) and (Figure 3). Mean solar radiation is 5, 342 MJ m2; annual average temperature is 7.0˚C. Plant growing period is 152 days.

Figure 1: The Location of Shanghuang eco-experiment station in China.

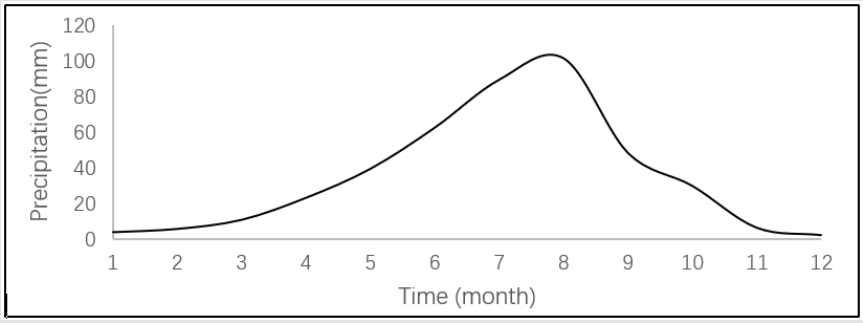

Figure 2: Change of average monthly precipitation with month in a year in the Shanghuang Eco-experimental Station.

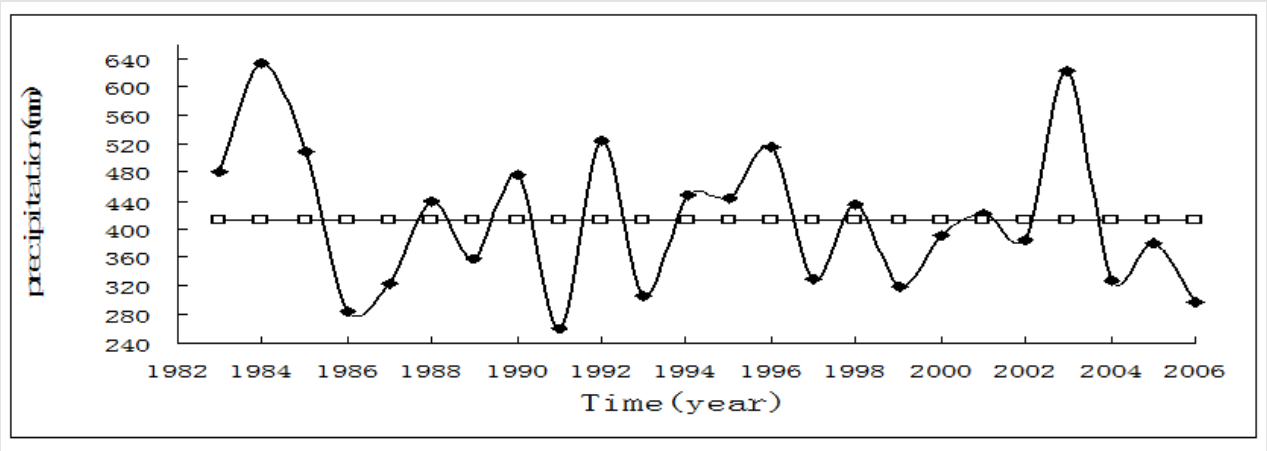

Figure 3: Change of precipitation with year in the Shanghuang Eco-experimental Station.

Groundwater level is more than 60 meters (Guo and Shao [7]). Low temperature, frost and drought are the main disaster weather which influence sustainable produce of red plum apricot. Since red plum apricot introduced in 1988 from Shaanxi province to the Shanghuang Eco-experimental Station, see (Figure 1) and (Figure 4). The precipitation is less, and the seasonal and interannual variations of precipitation are larger, soil dry often happens in the dry years, which will cause soil degradation, vegetation decline and corn failure, or waste of soil water resources because planting density is smaller than soil water carrying capacity for vegetation in wet years. Amelanchier alnifolia Nutt (common names: Saskatoon berry) is a pome fruit-bearing shrub native to the North American prairies (Moyo [8]). First it is transferred to plant in Liaoning, China in 1997and then be introduced to plant in Guyuan, China in 2008 because Saskatoon berries fruit are good sources of many bioactive phenolic components, such as flavonols, anthocyanins, procyanidins, and phenolic acids. As much as 382 mg/100 g based on fresh weight of anthocyanins, Anthocyanin- and flavonoid-rich foods have been demonstrated to have a beneficial protective function in combating certain cancers, inflammation and cardiovascular diseases, type II diabetes, obesity, and age-related macular degeneration, see (Figure 4).

Figure 4: Saskatoon berries grow well in the Shanghuang Eco-experimental Station.

Red plum apricot tree is a small tree and grows well. The shape of red plum apricot fruit is about round and looks beautiful, see (Figure 2). The fruit weight of red plum apricot per single fruit weight is about 40 -56 g. The apricot is rich in juice, soluble solids content (14.3%), potassium (410.8 mg per 100 g), selenium and Vc (8.3 mg per 100 g) (Gang, et al. [9]). The potassium content of red plum apricot is higher than that of apple (Malus domedtia), pear (Pyrus), peach (Amygdalus persica) and grape (Vitis vinifera), see (Figure 5). Corn is a native to Central and South America and now It is now grown all over the world. Corn contains rich vitamin, which are five times more vitamin for rice, wheat, which has the highest percentage of the content of vitamin A, every one hundred grams 63 micrograms of content, and the researchers point out that vitamin A is very beneficial to people's eyes. A nutritional factor, corn, with its powerful antioxidant to protect vision effect, and absorb harmful to the eyes of the useless components. Corn prevent obesity and constipation corn contains rich plant cellulose is not easy to be absorbed by the body, it can stimulate gastrointestinal peristalsis, promote fecal excretion. Corn can restrict the absorption of excessive sugar in the body, inhibit the increase of blood sugar in the body after dinner; Fiber can also inhibit fat absorption.

Figure 5: The shape of red plum Apricot in the Shanghuang Eco-experimental Station.

Corn can help people prevent obesity, but also can help people lose weight, to achieve the effect of beauty and thin body. One of the nutrients in corn is niacin, which plays an important role in the metabolism of fat and sugar and helps us maintain a healthy digestive system and healthy skin. Corn can prevent heart disease and cancer in the corn in addition to contain carbohydrates, carotene these common elements, it also contains vitamins and riboflavin, and nutritional factors contained in the corn, absorbed by the body and then transformed into has anti-cancer effects of vitamin, corn and rich plant fiber, it can make effective discharge carcinogens and other poisons, it also has the effect of stimulating the brain to enhance one's brain power and memory. In addition, selenium and magnesium contained in corn also have good anti-cancer effects. They can accelerate the decomposition of peroxides in the body, which can inhibit the growth and division of cancer cells, so that cancer cells are inhibited, and can also promote the discharge of waste in the body, which is also good for cancer prevention, see (Figure 6) the soil water and plant growth was investigate.

Figure 6: Corn plant will wilt in critical period of plant water relationship regulation in the Shanghuang Eco-experimental Station.

Result and Discussion

Resources Use Limit by Plants

Nature Resources is limit and plant use resources also is limit, The index that expresses the harmonious degree of the relationship between plant resources is the limit of utilization of plant resources. The plant resources relationship is the dynamics relationship. According to the harmony degree of the plant resources relationship, edible plants can be divided into two types: native plants and exotic plants. Because goods and services that native plant produced cannot meet the peoples need, so most of Edible plan belongs to exotic plants Exotic plants are those plants they are introduced from other places whether intentionally or introduced nointentionally. Intentional is often called introduction but introduced nointentionally called invasive species. Because some exotic plants have good ability to adapt themselves to the local environment, these plants do not need to regulate edible plant and resources relationship, such as Amelanchier alnifolia Nutt planted in the semiarid loess hilly region of China. Red plum apricot and corn all is not native to the semiarid loess hilly region of China.

After being introducing to the semiarid loess hilly region of China, the Amelanchier alnifolia plant grow fast and well and fast bear fruit. But, Corn in the semiarid loess hilly region of China (Guyuan, China) cannot adapt themselves to the dry environment. In such situation, corn should be sowed in April and mature in September. The plant resources relationship should be regulated according to resources use limit by plant and vegetation carry capacity. For example, the resources use limit by plants in the Shanghuang Eco-experimental Station is soil water resources use limit by plant. The soil water resources use limit by plant is soil water storage in the maximum infiltration depth when the soil moisture content of all layers within the maximum infiltration depth range is equal to the withering coefficient (Guo [10-13]). The Use Limit of Soil Water Resources by red plum apricot see (Table 1). When soil water resources in the maximum infiltration depth is equal to soil water resources use limit by plant. The plant water relationship should consider be regulated.

Table 1: The Use Limit of Soil Water Resources by red plum apricot.

Soil Depth (cm)	Representative Soil Layer (cm)	Wilting Coefficient (%)	Unavailable Soil Water Storage (mm)
0	0-10	7.98	7.98
20	30-Oct	7.48	14.96
40	30-60	7.59	22.77
80	60-100	7.72	30.88
120	100-140	6.68	26.72
160	140-180	7.51	30.04
200	180-220	7.41	29.64
240	220-290	7.1	49.7
Use Limit of Soil Water Resources by plant	0-290		212.69

Vegetation Carrying Capacity

Since the 1960s, soil drought has occurred in most of non-native forest, grass, and crop lands in the Loess Plateau of China. Vegetation carrying capacity is the ability of land resources to support vegetation, which can be defined as the maximum density (relative index) or population number (absolute index) of an indicator plant that land resources can support normal plant growth in a plant community. Carrying capacity of land for Vegetation is a measure of whether a plant community is using land resources sustainably and healthy growth. The good and service that the maximum density or population number can produce is the maximal good and service that land resources support plant to produce at this condition, which is the goal that people manage vegetation. Vegetation carrying capacity is the ability of land resources to support vegetation, which includes spatial vegetation carrying capacity, soil water-carrying capacity for vegetation and Soil nutrient carrying capacity for vegetation. Spatial vegetation carrying capacity is the ability of spatial resources to support vegetation.

Soil water carrying capacity for vegetation is the ability of soil water resources to support vegetation. soil water resources are the water storaged in the soil, especially in root zone and the critical period of plant water relationship regulation. limit plant growth when soil water and soil nutrient resources are adequate. Similarly, soil nutrient carrying capacity is limited by soil nutrient resources, while soil water carrying capacity is limited by soil water resources. Soil nutrient carrying capacity can be divided further into soil N carrying capacity, which is driven by soil N storage or resources, soil phosphorus (P) carrying capacity, which is driven by soil P storage or resources, and soil potassium (K) carrying capacity, which is driven by soil K storage or resources (Guo [14]). Vegetation Carrying Capacity is the maximum density (relative index) or population size (absolute index) of an indicator plant in a plant community when the soil water consumption equal soil water supply in the root zone soil over a given time scale, especially critical period of plant-water relationship regulation, minimum death days in which the relationship between soil water and plant growth decided plant growth condition during whole season and the maximal produce and service of a plant ecosystem in water-limited regions.

The plant-water plan relation has to be regulated on the Soil Water-Carrying Capacity for Vegetation. Otherwise, soil water drought would cause soil degradation, vegetation decline, or crop failure (Guo, et al. [15-19]).The maximum quantity or plant density soil water resources per unit area can maintain healthy growth of indicator plants at a given period and site condition (Guo & Shao [16]) and can be estimated by soil water-lant density model (Guo [11,12]), expressed by the number (absolute index) or density (relative index) of indicator plant in the plant community. Soil water carrying capacity for vegetation (SWCC), changing with plant species (vegetation type), time and location, is the theoretical basis for determining indicators and criteria for high quality and sustainable management of forest vegetation (Guo [11,12]). Soil water vegetation carrying capacity is limited in water shortage area, which is called soil water carrying capacity for vegetation (Guo, et al. [15]). It is the ability of soil water resources to support the vegetation (Guo, et al. [7,10,15-17]); (Guo [9,10,11-13,20]) or irrigation was used to add water to meet the need of plant water in water limited regions if there are water resources to make corn grow well in dry year to obtain maximum yield and beneficial result.

The Critical Period of Plant Water Relationship Regulation

Edible plant and resources relationship can be divided into two kinds, one is the balance or harmony relationship such as native plants in original vegetation. The relationship between plant resources is developed on the basis of long-term evolution, because plants have certain self-regulation ability and can self-regulate the relationship with nature. Even if the ecological environment changes to some extent within the limit of plant use resources during the season growth of plants, especially in the critical period of plant water relationship regulation as long as the available resources do not exceed the limit of the use of resources by plants, or the plants can adjust themselves to adapt to the changes, the plants will blossom and bear fruit. This kind of plant resource relationship is normal. Otherwise, Plant resources relationship has to be regulated. The critical period of plant water relationship regulation is the most important period in plant growing season that decides the maximum yield and benefit food plant, which is from the starting time soil water resources in the maximum infiltration depth equal soil water resources use limit by plant (Guo and Li [20]) to the failure time using soil water vegetation carrying capacity to regulate plant water relationship [21-25]. The soil water resources in the critical period of plant water relation regulation are the soil water resources in the root zone at the starting time of the critical period of plant water relation regulation plus soil water supply from precipitation through canopy in the critical period of plant water relation regulation (Guo [12,13]).

High Quality Production of Food Plant

In order to realize the sustainable utilization of resources and obtain maximum yield of food plant to realize high quality production of food and high quality and sustainable development of social economy, it is time to apply the limit of resources utilization by plant and the vegetation carrying capacity to adjust the relationship between plant growth and resources use and obtain the maximum yield and benefit of food plant and meet sustainable supply of plant-based foods in market , when the resources lack duration is more than the critical period of plant resources relationship regulation and the preserve plant density in the critical period of plant resources relationship regulation is more than vegetation carrying capacity, the plant resources relationship regulation must be adjusted. The soil water carry capacity for vegetation in the critical period of plant water relation regulation, which is the ability of soil water resources in the critical

period of plant water relation regulation to support vegetation. The reducing amount is equal to preserve density minus soil water carry capacity for vegetation denoted by the number or density of a population of indicative plants [26-28]. For example, the station belongs to the semi-arid Loess Hilly region, which belong to the water-limited regions, the limit theory of resource utilization by plant is the soil water resources utilization limit by plant and the carrying capacity of vegetation is soil water carrying capacity for vegetation because soil water mainly come from precipitation and underwater is deep and there is not irrigation condition [29-31]. According to three years study of red plum apricot from 2017 to 2020 in the station, the factors influencing the high quality production of red plum apricot is the low temperature and frost happened in the early spring from the last ten days of March to the middle ten days of April, which influences the development of flowers, pollination and young fruit of red plum apricot, heart-eating insects influences the young fruit of red plum apricot when the young fruit of red plum apricot grows to 0.8 ~ 1.0 cm in diameter, it becomes young fruit around May 20, and soil dry.

When the soil water resources in the maximum infiltration depth reduced to Soil Water Resources use limit by red plum apricot, the plant water relationship should be considered regulate. When the soil water resources shortage day is more than the critical period of plant water relationship regulation, showing that soil water severely influences plant growth. At this time, branch and leave quantity of red plum apricot is more than the suitable amount of branches and leaves, which is the amount of branches and leaves when the density is equal to the soil water carrying capacity of red plum apricot. Plant water relation generally should be regulated by pruning some branch and leave quantity instead of cutting some plant and then regulate the fruit and leave because the power of leave to produce carbohydrate.

Discussion

Indicate plant in original vegetation is native to the local region because they develop a good relation with local nature for a long time, plant resources relationship is very harmony and plant grow well and bear fruit but sometime the goods and service cannot meet people's need, so a lot of original vegetation has been changed into non-native plantation. As for man-made vegetation, while food plants grow and develop well, the amount of natural resources used by plants increases, but sometime the available resources decrease as plant grow because natural resources are limited. When the available resources decrease to the limit of resource utilization by plant, which is the function of plant species and location (Guo [11,12]), the relationship between plant growth and resources enter the critical period of plant resources relation regulation and plant resources relation must consider to be regulated. If the duration of resource lack is more than the critical period of plant resources relation regulation and the preserve density is more than the vegetation carrying capacity, which is the function of plant species, time and location, the plant resources relationship should be regulated, otherwise the further increase of natural resources used by plant will lead to the decline of vegetation and the decline of grain yield and quality.

Conclusion

The World Health Organization (WHO) evaluates the factors that affect human health, showing that the role of dietary nutritional factors (13%) is greater than that of medical factors (8%), second only to genetic factors (15%). According to the WHO Global Nutrition Report (2018 edition), 20% of deaths are related to dietary nutritional imbalance, and dietary nutritional factors have become the primary risk factors for global morbidity and mortality. For the health of the people and high-quality production and sustainable development of social economy, sustainable use of nature resources and the high-quality production of food must be carried out and the limit of resource utilization by plant in the water-limited regions is the soil water resources utilization limit by plant and the carrying capacity of vegetation is soil water carrying capacity for vegetation in water-limited regions should be used to prevent soil degradation and vegetation decline, and obtain maximum yield and promote high quality production of food plant.

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