Abstract: Red plum apricot is the best apricot over the world. Since having been introduced into Guyuan county in 1987 from Shaanxi province, red plum apricot grows well and then has been selected as good varieties to popularize in semirid loess hilly regions because the color of red plum apricot is beautiful, aroma fragrant, and taste is the mix of sour and sweet and nutrition is rich. Since 1995, the yield, benefits and planting area of red plum apricot increase doubly, and the distribution range of red plum apricot increased from Guyuan to the whole Ningxia, and then to Gansu province and so on in the water-limited regions, China. However, there are still some...
problems in the sustainable produce of red plum apricot. In order to promote the development of red plum apricot and meet people's increasing demand, we should do intensive study of the relationship between red plum apricot and environment and the comparison of possible methods to reduce the bad influence of drought, low temperature and frost on quality and production of red plum apricot, and determine the soil water resources use limit by red plum apricot and the suitable leaf amount of red plum apricot when the planting density equal soil water carrying capacity for red plum apricot and select the best method to reduce or evade the bad influence of soil drought, low temperature, frost and soil drought on red plum apricot to ensure the sustainable produce of red plum apricot in Sustainable Produce of red plum apricot in water-limited regions.

Keywords: Red plum apricot; fruit forest; planting area; benefits; soil water resources use limit by red plum apricot; suitable leaf amount of red plum apricot ;sustainable produce of red plum apricot

Introduction

The apricot (Prunus armeniaca L.) is a member of the Rosaceae, with subfamily of Prunoideae. Apricot which it is used as fresh, dried or processed fruit, is rich in many plant antioxidants and a good source of dietary fiber. Of the applications of apricot in food technology are producing dried fruit, frozen apricot, jam, jelly, marmalade, pulp, juice, nectar, extrusion products and so forth. Also, apricot is an economic fruit because its kernel is used for making oils, benzaldehyde, cosmetics, active carbon, and aroma perfume (Hacıseferoğlu et al., 2007). In the year 2014, Iran's apricot production amounted to 252,747 tones per year which came third after Uzbekistan and Turkey. The whole amount of apricot production was 3,365,738 tones
In most parts of the world, human activities, such as overgrazing, deforestation, denudation and reclamation have greatly altered the type of vegetation that dominates the landscape. These have accompanied the demand for food, fruit, timber and biofuels due to local population increases, which historically have frequently occurred in water-limited regions (Metcalfe and Kunin, 2006), such as the Loess Plateau of China (Guo and Shao, 2013). Since the 1949, with the increase of population, the most of land changed into farm land to produce food and meet the people’s increasing demand with people population increase. As a result, the native vegetation is destroyed irrationally, but the food yield is low, about 150 to 200 per Mu (Mu is Chinese area unit, 1 Mu = 666.7 m$^2$) and not stable, and not enough to meet the need of people for food. At the same time, the soil and water loss is serious and soil degrades because the soil loss modulus is between 5000 to 10000 t per square kilometer. In order to change this situation, increase people’s income and carry out sustainable development, since 1983, many economic forest species, such as red plum apricot, were introduced from Shaanxi fruit institute, China and planted in the Shanghuang Eco-experimental Station and have been compared and analysed in the same site condition. In 1995, red plum apricot was selected and promoted and developed fast after 1995. Red plum apricot not only promoted the development of local industry development, but there are also some problems need to be solved. In order to promote the development of apricot industry, the purpose of this study was to review the development of red plum apricot and find and overcome some limit factors of the development of the apricot and promote the sustainable produce of red plum apricot.

**Introduce of red plum apricot into the semi-arid region of the Loess Plateau**

The Shanghuang Eco-experimental Station was located in the semi-arid region of the Loess
Plateau, in the Eastern 20 Km from Guyuan County, in the Ningxia Hui Autonomous Region of western China, see fig.1. The area is 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. Mean solar radiation is 5, 342 MJ m²; annual average temperature is 7.0°C. Plant growing period is 152 days. Groundwater level is more than 60 meters (Guo and Shao, 2013).

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.

The root stock of red plum apricot is Armeniaca sibirica (L.) Lam, which means that Red plum apricot grafted on apricot. In the red plum apricot plantation, 3 trees was selected as sample. In every sample tree, 9 branches at different direction was selected and hang tag to investigate the base diameter and height growth with a 10 day interval from April to October in the growing season. The size and quality of red plum apricot fruit was measured and tasted. And then analyse the change of red plum apricot growth with time and the quality and yield of red plum apricot (Guo and Shi, 1993; Shi and Guo 1995).

Breeding and popularization of red plum apricot
In the Shanghuang Eco-experimental Station, red plum apricot grows well. The shape of red plum apricot fruit is about round and looks beautiful. The size of fruit is big, see fig 2. The fruit weight of red plum apricot per single fruit weight is about 36 -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, 2011). The potassium content of red plum apricot is higher than that of apple (Malus pumila), pear (Pyrus), peach (Amygdalus persica) and grape (Vitis vinifera). After a couple of years study from 1987 to 1991 in the Shanghuang Eco-experimental Station, red plum apricot is selected and popularization because red plum apricot fruit is mature early, and fruit is larger, and quality is high, and production is stable (Shi and Guo, 1995; Guo 2013). Some 3-years-old Red plum apricot begins to bears fruit, and 4-years-old Red plum apricot obtain higher yield planting in the station. It starts to germinate in March 28(Guo and Si, 1993) and expand leaf in the middle of April. Red plum apricot blooms from late March to early April and blooms, and bears fruit in mid-April. Fruit ripes in the early July in the eco-experiment station, Guyuan County in the Ningxia Hui Autonomous Region. Red plum apricot is used as fresh food as well as raw material, such as making dried fruit by wind-drying.

In 2008, we found the serious influence of a heart-eating insects (grapholitha molesta (Busck) on fruit quality, 67% of red plum apricot fruit of 100 kg was suffer the pest injury, which has the most pest influence on the qaulity of red plum apricot. We select the high efficiency cypermethrin, a kind of efficient and Low toxicity pesticide on the Red plum apricot and selected 28 red plum apricot as sample tree and spraying red plum apricot with 2000 times high efficiency cypermethrin in the period from May 20 to 27 in apricot garden of the eco-experiment station . The fruit eaten by heart-eating decreased to 1/1000. Because the cypermethrin is high efficiency and low toxin,
and become failure after 7 days. According to the test report made by Xi’an United Nations Quality detection Technology Co., Ltd, China in Julay, 2019, Cypermethrin concentration in Red plum apricot is not texted, showing that Cypermethrin concentration is low than 0.003mg per KG and the control effect of efficient cypermethrin on heart-eating insects is very good. The control method using efficient cypermethrin on heart-eating insects is continue to use.

Since 2009, the control technology of this a heart-eating insects with efficient cypermethrin is popuralization (Guo 2013). The apricot yield is about 1000Kg per Mu (Chinese unit, and 1 mu equals 666.7 m²). The price is changed with market and increases from 1.2 yuan (RMB) in 1987 to 20 yuan per kilogram in 2017 and 2019. The econmic benefit is about 20,000 RMB per Mu, which is the 20 times as same as that of local main crops, such as broom corn millet (Panicum miliaceum), Common wheat (Triticum aestivum), corn (Zea mays) and millet (Setaria italica). The planting area of Red plum apricot increase doubly. The distribution range of Red plum apricot increase from Guyuan to the whole Ningxia, and then to Gansu province and so on in the water-limited regions, China.

**Sustainable Produce of red plum apricot**

Although Red plum apricot is anty-drought, anty-cold and anty-frost, the high-yield, high-benefit plantation not only bear fine fruit, increase income of farmer, fix carbon dioxide, improve and beautify ecological environment, but in the process of plantation in the water-limited regions, sometime soil desiccation often occurs and quickly changes into severe desiccation and causes soil degradation and part branches or whole tree death, which waste soil water resources and influence the Sustainable Produce of red plum apricot because as plant grow, the Branch and leaf quantity of canopies is increasing, which increase the canopies interception and soil water
consumption and reduce the soil water supply. Low temperature and frost often happens in the period of Red plum apricot flowering because of low temperature and frost. The soil desiccation, low temperature and frost will reduce the quality, yield and economic benefits in the water-limited regions, so it is necessary to take effective method to reduce the influence of drought, low temperature and frost on the quality and yield of Red plum apricot.

In order to protect the germplasm resource of red plum apricot and promote the development of red plum apricot industry and realize the Sustainable Produce of red plum apricot, we establish the National high quality red plum apricot demonstration area in 2018, see fig.3. In order to reduce the influence of drought on the quality and yield of Red plum apricot, we should regulate the relationship between Red plum apricot growth and soil water at the appropriate time by reducing some flower, branches and leaf present to increase the soil water supply and reduce soil water consumption to ensure the form of harmonious relationship between Red plum apricot growth and soil water and sustainable use soil water resources (SUSWR) by plants, stability of plantation ecosystems in water-limited regions. The theory of SUSWR includes the soil water resources use limit by plants (SWRULP) and soil water carrying capacity for vegetation (SWCCV). SWRULP is the soil water storage in the maximum infiltration depth (MID) in which the soil water content in every soil layer equals wilting coefficient, which limits flowering and fruiting of plant. The available amount of branches and leaf is the branches and leaf when the density is equal to the SWCCV when the soil water supply (SWS) is equal to soil water consumption (SWC) in the root zone in the key regulating period within a growing season. Generally, the relationship between fruit tree growth and soil water can be regulated by changing the amount of tree or plant (Guo, 2014), as for some plant, such as red plum apricot, the relationship often can be regulated by...
cutting some of vimens or leaf or fruit in the key regulating period within fruit expansion period
because the relationship between fruit tree growth and soil water has to be regulated by changing
the amount of vimens or leaf or fruit.

According to the study in 2018, the maximum infiltration depth is 290cm, and wilting
coefficient varies with soil depth from 7.98 in surface soil to 7.1% in 240 cm soil depth, and the
soil water resources use limit by red plum apricot is 212.7 mm. The soil water resources in the
maximum infiltration depth in the growing season for the 1-year-old red plum apricot and
23-year-old red plum apricot is more than the soil water resources use limit by Red plum apricot
of 212.7 mm, and red plum apricot grow well, so, we do not need to regulate the red plum apricot
because the precipitation in 2018 is 536.2 mm, which is 120.6 mm more than the mean
precipitation 415.6 mm and close to the maximum rainfall record of 634.7 mm in the National
high quality red plum apricot demonstration area. But the effect of low temperature and frost
happened on April 7 on the blooming of Red plum apricot is more serious than in 2019, which
freezed all the blooming flower of red plum apricot in 2018.

In order to reduce the influence of low temperature and frost on the quality and yield of red
plum apricot, we should compare theose possible method, such as smoke method, Spraying
antifreeze or water and so on, and then select the best method to reduce the bad influence on the
quality and yield of red plum apricot and increase benefits. The flowers of Red plum apricot in the
almost of the Ningxia Hui Autonomous region were died by low temperature and frost on April 7,
2018. Some red plum apricot was freezed by low temperature and frost in 2019.

In addition, the selection of picking time is important. We should fast harvest the matured red
plum apricot fruit as soon as possible because the freak appeared on the base of fruit when red
plum apricot fruit matured after 2-3 day, see fig.4. The length of the freak and the depth of the
freak increase with time when the red plum apricot fruit has been mature, which influence the
quality and beneficial result

Discussion

In the most part of water-limited regions, such as Loess plateau of China, the soil water mainly
from the throughfall because the water table is deep and without irrigation. As plant grow, plant
height, breast diameter or basic diameter and the branch and leaf quantity of canopies is
increasing, which increase the canopies interception and soil water consumption and reduce the soil
water supply. Soil water resources use limit by plants (SWRULP) is the soil water storage or soil
water resources in the maximal infiltration depth (MID), which is the controlled standard plant use
soil water. When all soil water content in the MID is equal SWRULP, the soil water severe
influence the plant growth. Two curves method was used to estimate infiltration depth and soil
water supply for a rain event (Guo, 2004). A series of two curves methods for maximal infiltration
depth for a long time infiltration process (Guo and Shao 2009, Guo 2014, 2017).

Soil water carrying capacity for vegetation (SWCCV) is the ability of soil water resources to bear
vegetation. The SWCCV is the population quantity or density of indicator plant in a plant
community when the soil water supply (SWS) is equal to soil water consumption (SWC) in the root
zone in a growing season (Guo, 2014), which is indicated by suitable amount of branches and
leaves for economic forest, such as red plum apricot in red plum apricot forest because the
relationship between soil water and plant growth was regulated by pruning some branches and
leaves. When the soil water resources equal to SWRULP, soil water sever influence red plum
apricot growth, finally size of single fruit, yield and benefit of red plum apricot. At this time, we
should prune some branches and leaves based on the suitable amount of branches and leaves.

Besides soil drought, low temperature and frost is another main factor influencing the quality and yield of red plum apricot in water-limited regions. Even if there are a lot of measures to reduce the influence of low temperature and frost on the quality and yield of red plum apricot, but some measures are effective and others is bad, such as delay bloom time by irrigating in the semi-arid region because water resources is lack. In order to effectively reduce the influence of low temperature and frost on the quality and yield of red plum apricot, we should compare the possible method, such as smoke method, Spraying antifreeze or water and so on, and select best measure to use.

**Conclusion**

Red plum apricot is one of the best fruit and food in the world. In the near future, planting area of red plum apricot area will enlarge and we should do intensive study of the relationship between red plum apricot production and environment and determine the soil water carrying capacity for red plum apricot and compare possible methods to reduce the influence of drought, low temperature and frost on the quality and yield of red plum apricot, and then take the appropriate method to regulate the relationship between red plum apricot growth and soil water or reduce or evade the bad influence of low temperature, frost and soil drought to ensure the sustainable produce of red plum apricot.

In a word, we should continue to increase the planting area and enlarge the distribution range of red plum apricot to produce more red plum apricot fruit to meet the increasing need of urban residents for fine red plum apricot fruit. At the same time, we should increase the income of farmer who plant red plum apricot in countryside under the condition of keeping sustainable use.
of nature resources and sustainability of fine environment to realize sustainable development.

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

Fig. 2, the shape of Red plum apricot in Shuanghuang eco-experimental Station
Fig. 3 the National high quality red plumapricot demonstration base in the Shanghuang eco-experiment station in 2019
Fig. 4. Red plum apricot with different maturity in 2019