

1 Sustainable Produce of Red Plum Apricot in Water-Limited Regions

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16 **Abstract:** Red plum apricot is the best apricot over the world. Since having been introduced into

17 Guyuan county in 1987 from Shaanxi province, red plum apricot grows well and then has been

18 selected as good varieties to popularize in semirid loess hilly regions because the color of red

19 plum apricot is beautiful, aroma fragrant , and taste is the mix of sour and sweet and nutrition is

20 rich. Since 1995, the yield, benefits and planting area of red plum apricot increase doubly, and the

21 distribution range of red plum apricot increased from Guyuan to the whole Ningxia, and then to

22 Gansu province and so on in the water-limited regions, China. However, there are still some

23 problems in the sustainable produce of red plum apricot. In order to promote the development of
24 red plum apricot and meet people's increasing demand, we should do intensive study of the
25 relationship between red plum apricot and environment and the comparison of possible methods to
26 reduce the bad influence of drought, low temperature and frost on quality and production of red
27 plum apricot, and determine the soil water resources use limit by red plum apricot and the suitable
28 leaf amount of red plum apricot when the planting density equal soil water carrying capacity for
29 red plum apricot and select the best method to reduce or evade the bad influence of soil drought,
30 low temperature, frost and soil drought on red plum apricot to ensure the sustainable produce of
31 red plum apricot in Sustainable Produce of red plum apricot in water-limited regions.

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

35 **Introduction**

36 The apricot (*Prunus armeniaca* L.) is a member of the Rosaceae, with subfamily
37 of Prunoideae. Apricot which it is used as fresh, dried or processed fruit, is rich in
38 many plant antioxidants and a good source of dietary fiber. Of the applications of
39 apricot in food technology are producing dried fruit, frozen apricot, jam, jelly,
40 marmalade, pulp, juice, nectar, extrusion products and so forth. Also, apricot is an
41 economic fruit because its kernel is used for making oils, benzaldehyde, cosmetics,
42 active carbon, and aroma perfume (Hacıseferoğulları et al., 2007). In the year 2014,
43 Iran's apricot production amounted to 252,747 tones per year which came third after
44 Uzbekistan and Turkey. The whole amount of apricot production was 3,365,738 tones

45 (Khojastehnazhand et al., 2019)

46 In most parts of the world, human activities, such as overgrazing, deforestation, denudation and
47 reclamation have greatly altered the type of vegetation that dominates the landscape. These have
48 accompanied the demand for food, fruit, timber and biofuels due to local population increases,
49 which historically have frequently occurred in water-limited regions (Metcalf and Kunin, 2006),
50 such as the Loess Plateau of China (Guo and Shao, 2013). Since the 1949, with the increase of
51 population, the most of land changed into farm land to produce food and meet the people's
52 increasing demand with people population increase. As a result, the native vegetation is destroyed
53 irrationally, but the food yield is low, about 150 to 200 per Mu (Mu is Chinese area unit, 1 Mu =
54 666.7 m²) and not stable, and not enough to meet the need of people for food. At the same time,
55 the soil and water loss is serious and soil degrades because the soil loss modulus is between 5000
56 to 10000 t per square kilometer. In order to change this situation, increase people's income and
57 carry out sustainable development, since 1983, many economic forest species, such as red plum
58 apricot, were introduced from Shaanxi fruit institute, China and planted in the Shanghuang
59 Eco-experimental Station and have been compared and analysed in the same site condition. In
60 1995, red plum apricot was selected and promoted and developed fast after 1995. Red plum
61 apricot not only promoted the development of local industry development, but there are also some
62 problems need to be solved. In order to promote the development of apricot industry, the purpose
63 of this study was to review the development of red plum apricot and find and overcome some limit
64 factors of the development of the apricot and promote the sustainable produce of red plum apricot.

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

66 The Shanghuang Eco-experimental Station was located in the semi-arid region of the Loess

67 Plateau, in the Eastern 20 Km from Guyuan County, in the Ningxia Hui Autonomous Region of
68 western China, see fig.1. The area is located in a hilly loess region with an elevation range of
69 1,534 to 1,824 m and slope gradients of 0° to 10° and the slope gradients below the valley shoulder
70 line is more than 25°. The main soil type is Huangmian soil (Calcaric Cambisol, FAO 1988) that is
71 developed from loess and is susceptible to soil and water losses, which are serious in this region.
72 The rainfall is unevenly distributed in the year with a mean annual precipitation of 416 mm, and
73 rainfall from June to September accounts for 64.7 % of the total annual precipitation. The
74 coefficient of variation of precipitation among the years from 1983 to 2001 was 23.8% and rainfall
75 amounts ranged from 259.9 mm in 1991 to 634.7 mm in 1984, with a median rainfall amount of
76 434 mm. Mean solar radiation is 5, 342 MJ m²; annual average temperature is 7.0°C. Plant
77 growing period is 152 days. Groundwater level is more than 60 meters (Guo and Shao, 2013).
78 Low temperature, frost and drought are the main disaster weather which influence sustainable
79 produce of red plum apricot. Since red plum apricot introduced in 1988 from Shaanxi province to
80 the Shanghuang Eco-experimental Station.

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

88 **Breeding and popularization of red plum apricot**

89 In the Shanghuang Eco-experimental Station, red plum apricot grows well. The shape of red
90 plum apricot fruit is about round and looks beautiful. The size of fruit is big, see fig 2. The fruit
91 weight of red plum apricot per single fruit weight is about 36 -56 g. The apricot is rich in juice,
92 soluble solids content (14.3%), potassium (410.8 mg per 100 g), selenium and Vc (8.3 mg per 100
93 g) (Gang et al, 2011). The potassium content of red plum apricot is higher than that of apple
94 (*Malus pumila*), pear (*Pyrus*), peach (*Amygdalus persica*) and grape (*Vitis vinifera*). After a couple
95 of years study from 1987 to 1991 in the Shanghuang Eco-experimental Station, red plum apricot is
96 selected and popularization because red plum apricot fruit is mature early, and fruit is larger, and
97 quality is high, and production is stable (Shi and Guo, 1995; Guo 2013). Some 3-years-old Red
98 plum apricot begins to bears fruit, and 4-years-old Red plum apricot obtain higher yield planting
99 in the station. It starts to germinate in March 28(Guo and Si, 1993) and expand leaf in the middle
100 of April. Red plum apricot blooms from late March to early April and blooms, and bears fruit in
101 mid-April. Fruit ripens in the early July in the eco-experiment station, Guyuan County in the
102 Ningxia Hui Autonomous Region. Red plum apricot is used as fresh food as well as raw material,
103 such as making dried fruit by wind-drying.

104 In 2008, we found the serious influence of a heart-eating insects (*grapholitha molesta* (Busck)
105 on fruit quality, 67% of red plum apricot fruit of 100 kg was suffer the pest injury, which has the
106 most pest influence on the quality of red plum apricot. We select the high efficiency cypermethrin,
107 a kind of efficient and Low toxicity pesticide on the Red plum apricot and selected 28 red plum
108 apricot as sample tree and spraying red plum apricot with 2000 times high efficiency cypermethrin
109 in the period from May 20 to 27 in apricot garden of the eco-experiment station . The fruit eaten
110 by heart-eating decreased to 1/1000. Because the cypermethrin is high efficiency and low toxin,

111 and become failure after 7 days. According to The test report made by Xi'an United Nations
112 Quality detection Technology Co.,Ltd, China in Julay, 2019, Cypermethrin concentration in Red
113 plum apricot is not texted, showing that Cypermethrin concentration is low than 0.003mg per KG
114 and the control effect of efficient cypermethrin on heart-eating insects is very good. The control
115 method using efficient cypermethrin on heart-eating insects is continue to use.

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

125 **Sustainable Produce of red plum apricot**

126 Although Red plum apricot is anty-drought, anty-cold and anty-frost, the high-yield ,
127 high-benefit plantation not only bear fine fruit, increase income of farmer, fix carbon dioxide,
128 improve and beautify ecological environment, but in the process of plantation in the water-limited
129 regions, sometime soil desiccation often occurs and quickly changes into severe desiccation and
130 causes soil degradation and part branches or whole tree death, which waste soil water resources
131 and influence the Sustainable Produce of red plum apricot because as plant grow, the Branch and
132 leaf quantity of canopies is increasing, which increase the canopies interception and soil water

133 consumption and reduce the soil water supply . Low temperature and frost often happens in the
134 period of Red plum apricot flowering because of low temperature and frost. The soil desiccation,
135 low temperature and frost will reduce the quality, yield and economic benefits in the water-limited
136 regions, so it is necessary to take effective method to reduce the influence of drought, low
137 temperature and frost on the quality and yield of Red plum apricot.

138 In order to protect the germplasm resource of red plum apricot and promote the development
139 of red plum apricot industry and realize the Sustainable Produce of red plum apricot, we establish
140 the National high quality red plum apricot demonstration area in 2018, see fig.3. In order to reduce
141 the influence of drought on the quality and yield of Red plum apricot, we should regulate the
142 relationship between Red plum apricot growth and soil water at the appropriate time by reducing
143 some flower, branches and leaf present to increase the soil water supply and reduce soil water
144 consumption to ensure the form of harmonious relationship between Red plum apricot growth and
145 soil water and sustainable use soil water resources (SUSWR) by plants, stability of plantation
146 ecosystems in water-limited regions. The theory of SUSWR includes the soil water resources use
147 limit by plants (SWRULP) and soil water carrying capacity for vegetation (SWCCV) . SWRULP
148 is the soil water storage in the maximum infiltration depth (MID) in which the soil water content in
149 every soil layer equals wilting coefficient, which limits flowering and fruiting of plant. The
150 available amount of branches and leaf is the branches and leaf when the density is equal to the
151 SWCCV when the soil water supply (SWS) is equal to soil water consumption (SWC) in the root
152 zone in the key regulating period within a growing season. Generally, the relationship between
153 fruit tree growth and soil water can be regulated by changing the amount of tree or plant (Guo,
154 2014), as for some plant, such as red plum apricot, the relationship often can be regulated by

155 cutting some of vimens or leaf or fruit in the key regulating period within fruit expansion period
156 because the relationship between fruit tree growth and soil water has to be regulated by changing
157 the amount of vimens or leaf or fruit.

158 According to the study in 2018, the maximum infiltration depth is 290cm, and wilting
159 coefficient varies with soil depth from 7.98 in surface soil to 7.1% in 240 cm soil depth, and the
160 soil water resources use limit by red plum apricot is 212.7 mm. The soil water resources in the
161 maximum infiltration depth in the growing season for the 1-year-old red plum apricot and
162 23-year-old red plum apricot is more than the soil water resources use limit by Red plum apricot
163 of 212.7 mm, and red plum apricot grow well, so, we do not need to regulate the red plum apricot
164 because the precipitation in 2018 is 536.2 mm, which is 120.6 mm more than the mean
165 precipitation 415.6 mm and close to the maximum rainfall record of 634.7 mm in the National
166 high quality red plum apricot demonstration area. But the effect of low temperature and frost
167 happened on April 7 on the blooming of Red plum apricot is more serious than in 2019, which
168 freezed all the blooming flower of red plum apricot in 2018.

169 In order to reduce the influence of low temperature and frost on the quality and yield of red
170 plum apricot, we should compare those possible method, such as smoke method, Spraying
171 antifreeze or water and so on, and then select the best method to reduce the bad influence on the
172 quality and yield of red plum apricot and increase benefits. The flowers of Red plum apricot in the
173 almost of the Ningxia Hui Autonomous region were died by low temperature and frost on April 7,
174 2018. Some red plum apricot was freezed by low temperature and frost in 2019.

175 In addition, the selection of picking time is important. We should fast harvest the matured red
176 plum apricot fruit as soon as possible because the freak appeared on the base of fruit when red

177 plum apricot fruit matured after 2-3 day, see fig.4. The length of the freak and the depth of the
178 freak increase with time when the red plum apricot fruit has been mature, which influence the
179 quality and beneficial result

180 **Discussion**

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

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

199 should prune some branches and leaves based on the suitable amount of branches and leaves.

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

208 **Conclusion**

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

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

221 of nature resources and sustainability of fine environment to realize sustainable development.

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

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Fig.2, the shape of Red plum apricot in Shuanghuang eco-experimental Station

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Fig.3 the National haigh quality red plumapricot demonstration base in the Shanghuang eco-experiment station in 2019

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Fig.4. Red plum apricot with different maturity in 2019

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