Preliminary study on the effect of irrigation during dry winters on litchi production

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Why Research?

- The winter drought or moderately moist favor litchi production? We found a few information in the official report.
- Some reports say: drought winter is Conducive yield.
- But, we can see higher yield in some year at moist climate in winter.
This study is based on the research:

“Relationship between winter irrigation and spring flowering of Guiwei litchi trees”, carried out further exploration on the relationship of soil moisture in winter and litchi production.
1. Materials and methods

1.1 The overview of the test orchard

The test garden in the experimental orchard located at the Fruit Tree Research Institute of Academy of Agricultural Sciences of Guangdong Province (Wushan, Tianhe District, Guangzhou City).
1.2 Methods

1.2.1 The irrigation experiment of Guiwei litchi

(1) The laying of rain shelter (for artificial drought)

September 2009, in the multi-level terraces of the tested orchard, select the middle of the two terraces covered with air and light anti-canopy, allowing at 80% light transmission. The soil under rain shed is relatively dry in the rain. The field management was in accordance with the conventional.
(2) Irrigation in the winter of 2009-2010

Each treatment to select eight of the main branch of fruit tree growing and the same size basically, the main branch was born in the two crown size $4 \times 4$ m Guiwei litchi tree, a total of four irrigation treatments: A, B, C, D; per each tree irrigation 150kg for one time. Drought control trees under the rain shelter had been no irrigation throughout the winter. Wet control litchi trees were at the open orchard.
About moist control:

- Due to the characteristics of early spring 2009 to the end of 2010 early in the test orchard in Guangzhou, where a reversal of previous years, the winter was often drought, winter and spring rain was very abundant, Therefore, the trees outside the rain shelter as in early December began irrigation, moist control times (five times or more) watering in this study.
Irrigation date

- Treatment A, irrigation dates were January 4, 2010; January 18, February 2 and February 11;
- Treatment B, irrigation dates were January 18, 2010, February 2 and February 11;
- Treatment C, irrigation dates were February 2 2010 and February 11;
- Treatment D, irrigation date was February 11;
- About 7-15 days Irrigation once.
(3) 2010-2011 winter irrigation methods in rain shed

- 2010, tested in winter of the main branch of the trees canopy size are similar that of 2009, each time to each of litchi trees watering 150kg(liter), a total of six irrigation treatments.
The six irrigation treatments were:

- Treatment a, water 6 times (December 27, 2010; January 7, 2011, January 18, January 25, February 14, March 3);
- Treatment b, irrigation 5 times (January 7, 2011; January 18, January 25, February 14, March 3);
- Treatment c, water four times (January 18, 2011 January 27, February 14, March 3 watering);
- Treatment d, water 3 times (January 25, 2011; February 14, March 3);
- Treatment e, water two times (February 14, March 3 watering time);
- Treatment f, irrigated 1 time (March 3);
- Drought control no watering.
(4) Outdoor orchard irrigation in winter of 2010-2011

- Open orchard irrigation test methods just like in rain shed, six irrigation treatments and the corresponding anti-canopy respectively, were set to:
  - treatment 1 (watering 6 times),
  - treatment 2 (watering 5 times),
  - treatment 3 (watering 4 times),
  - treatment 4 (watering 3 times),
  - treatment 5 (watering twice),
  - treatment 6 (watering 1 time) and
  - the control not irrigated (natural open-air control).
- 2010 autumn and winter were drought, greatly reducing the total rainfall over a normal year.
1.2.2 The methods of irrigation test of Nuomici litchi

- In the winter period from January 2011 to February, 4 Nuomici litchi trees, irrigation treatment with 4 times: January 7, 2011; January 18, January 25, February 14. Water each time per plant was about 150kg. Control trees no irrigation, and far away from the treatment trees.
1.3 Survey method

1.3.1 The determination of the surface soil moisture content and flowering rate

Measuring 10 points, calculating the average moisture content of the soil surface, soil surface water content were measured by “soil moisture meter” for each treatment. Soil moisture meter manufactured by “Zhejiang Top Instrument Co., Ltd”. Model: TZS-1. The water content is expressed in terms of volume percentage.
The measurement dates of 2009-2010 winter were as follows:

- 2010.01.07,
- 2010.02.10,
- 2010.02.23,
- a total of three times.
2010-2011 winter and spring, respectively, measured 14 times

- The determination dates:
  - 2010.12.17,
  - 2010.12.23,
  - 2010.12.27,
  - 2010.12.29,
  - 2011.01.07,
  - 2011.01.10,
  - 2011.01.17,
  - 2011.01.24,
  - 2011.01.26,
  - 2011.02.01,
  - 2011.02.11,
  - 2011.02.14,
  - 2011.02.22,
  - 2011.03.03.
TZS-I moisture meter

- The measuring probe is 80 mm in length, so the soil moisture content is surface soil moisture.
The statistics of the rate of flowers were in the spikes of each treatment is fully developed and will be flowering, respectively.
1.3.2 Determination of litchi fruit production

When the litchi fruit was ripe, respectively, statistics tested individuals yield, calculated the list and comparative analysis.
2. Results and analysis

2.1 The impact of irrigation in dry winter on Guiwei litchi production

Please see table 1
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average Yield (kg/tree)</th>
<th>Compared with CK2</th>
<th>Water content of topsoil (%)</th>
<th>Flowering rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>moist control (CK1)</td>
<td>13.5</td>
<td>13.0</td>
<td>27.3</td>
<td>76.4</td>
</tr>
<tr>
<td>irrigated</td>
<td>14.0</td>
<td>13.5</td>
<td>21.3</td>
<td>69.0</td>
</tr>
<tr>
<td>4 times irrigated</td>
<td>1.5</td>
<td>1.0</td>
<td>17.1</td>
<td>16.9</td>
</tr>
<tr>
<td>3 times irrigated</td>
<td>0.5</td>
<td>0</td>
<td>15.9</td>
<td>10.0</td>
</tr>
<tr>
<td>2 times irrigated</td>
<td>1.0</td>
<td>0.5</td>
<td>14.3</td>
<td>15.7</td>
</tr>
<tr>
<td>1 time drought</td>
<td>0.5</td>
<td>--</td>
<td>12.4</td>
<td>19.5</td>
</tr>
<tr>
<td>Control (CK2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
From Table 1, it is evident that:

- The flowering rate of moist control and irrigation times were much higher than the irrigation fewer and drought control. The preliminary phenomenon shows: irrigation in the dry winter may improve the flowering rate and increase the fruit yield.
The research of continuation

- This study is the continuation research for “Relationship between winter irrigation and spring flowering of Guiwei litchi trees”.
- The flowering rate data is the use of our previous research data.
The data of 2011 Guiwei litchi production also show that:

- The irrigation test trees under the conditions of artificial dry winter in rain shed, the average yield per plant were higher than the same in rain shed arid control production.
- The highest yield is the six times irrigations treatment.
- Please See table 2.
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average Yield (kg/tree)</th>
<th>Compared with control (kg/tree)</th>
<th>Water content (%)</th>
<th>Flowering rate(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation 6 times</td>
<td>13.9</td>
<td>13.9</td>
<td>15.25</td>
<td>89.10</td>
</tr>
<tr>
<td>Irrigation 5 times</td>
<td>10.7</td>
<td>10.7</td>
<td>12.94</td>
<td>75.88</td>
</tr>
<tr>
<td>irrigation 4 times</td>
<td>8.3</td>
<td>8.3</td>
<td>11.68</td>
<td>87.57</td>
</tr>
<tr>
<td>irrigation 3 time</td>
<td>5.2</td>
<td>5.2</td>
<td>10.86</td>
<td>75.39</td>
</tr>
<tr>
<td>Irrigation 2 times</td>
<td>13.1</td>
<td>13.1</td>
<td>9.70</td>
<td>32.6</td>
</tr>
<tr>
<td>Irrigation 1 time</td>
<td>6.9</td>
<td>6.9</td>
<td>9.47</td>
<td>15.29</td>
</tr>
<tr>
<td>Drought control</td>
<td>0.0</td>
<td>--</td>
<td>8.75</td>
<td>6.49</td>
</tr>
</tbody>
</table>
The Results of yield in 2011

- For the trees of Guiwei litchi in the open orchard, under irrigation conditions, the fruit yield of each watering treatment were higher than the natural drought control too. See Table 3 please.
<table>
<thead>
<tr>
<th>treatment</th>
<th>Average Yield (kg/tree)</th>
<th>Compared with control (kg/tree)</th>
<th>Water content (%)</th>
<th>Flowering rate(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>21.3</td>
<td>14.6</td>
<td>17.10</td>
<td>96.96</td>
</tr>
<tr>
<td>6 times</td>
<td>17.1</td>
<td>10.4</td>
<td>14.64</td>
<td>96.63</td>
</tr>
<tr>
<td>Irrigation</td>
<td>18.5</td>
<td>11.8</td>
<td>13.86</td>
<td>93.17</td>
</tr>
<tr>
<td>5 times</td>
<td>18.5</td>
<td>11.8</td>
<td>13.86</td>
<td>93.17</td>
</tr>
<tr>
<td>irrigation</td>
<td>12.3</td>
<td>5.6</td>
<td>13.27</td>
<td>93.99</td>
</tr>
<tr>
<td>4 times</td>
<td>12.3</td>
<td>5.6</td>
<td>13.27</td>
<td>93.99</td>
</tr>
<tr>
<td>irrigation</td>
<td>8.7</td>
<td>2.0</td>
<td>12.94</td>
<td>68.41</td>
</tr>
<tr>
<td>3 times</td>
<td>8.7</td>
<td>2.0</td>
<td>12.94</td>
<td>68.41</td>
</tr>
<tr>
<td>Irrigation</td>
<td>14.2</td>
<td>7.5</td>
<td>12.80</td>
<td>54.61</td>
</tr>
<tr>
<td>2 times</td>
<td>14.2</td>
<td>7.5</td>
<td>12.80</td>
<td>54.61</td>
</tr>
<tr>
<td>Irrigation</td>
<td>6.7</td>
<td>-</td>
<td>12.78</td>
<td>56.83</td>
</tr>
<tr>
<td>1 time</td>
<td>Drought</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>control</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.2 The Comparison of Nuomici litchi Yield with dry winter irrigation and natural drought in 2011

- Preliminary tests showed that:
- The dry winter irrigation on the role of improving Nuomici litchi production is also obvious.
- Before and after early January, the plants irrigation in dry winter in 2011, the average yield per plant was 14kg higher than the control by the natural drought, an increase of nearly 1.5 times.
The experimental data are listed in Table 4:

<table>
<thead>
<tr>
<th>Yield per plant (kg)</th>
<th>Total output (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>tree 1</td>
<td>tree 2</td>
</tr>
<tr>
<td>Irrigation (treatment)</td>
<td>18</td>
</tr>
<tr>
<td>Drought (CK)</td>
<td>11</td>
</tr>
</tbody>
</table>
3 Discussion and conclusions

3.1 Litchi production and Irrigation in dry winter

The experiment of litchi Nuomici irrigation in dry winter and Guiwei litchi irrigated in winters for two consecutive years show that:

- Irrigation in dry winter may improve the production of litchi. Dry winter irrigation conducive the litchi into flower and fruiting.
We observed the flower buds of Guiwei litchi sprouting 3-7 days early than drought control in the irrigation experiment too.
3.2 Irrigation in dry winter and the accumulation of the nutrients

- The authors speculated that:
  - The photosynthesis of litchi in winter depends on the same timely and appropriate soil moisture.
  - Irrigation in dry winter is conducive to carbohydrate synthesis and accumulation of minerals and other nutrients, and the physiological differentiation and the morphological differentiation of flower buds, which is beneficial to flowers and fruit set.
The accumulation of more nutrients in winter, may also be of great help to the growth and development of litchi fruit, and thus help to improve litchi production.
3.3 With regard to the moisture content of surface soil in winter of litchi orchard and flower rates

- This study shows that: timely and appropriate wet winter soil conducive to the litchi flower.
- With the traditional views “drought winter litchi flower“, this phenomenon is differing on the contrary.
3.4 Litchi red tip with water in spring

- This test was observed: under the moist autumn or winter conditions, litchi flower buds germinating spikes ahead a few days.
- So that flower buds may Development in the relatively low temperature environment, thus can play an important role to reduce the red tip of litchi in spring.
3.5 Dry winter irrigation and winter tip

- As we know: In early winter, if the soil is moist appropriate, the winter shoots will germinate and grow easily.
- If irrigation is required in the dry winter, we should select the time period of the lowest temperatures in the winter of local.
- If irrigation premature, may induce a large number of winter shoot, is not conducive to flower and fruit set.
Important attention

- In majority of litchi production areas, if the leaves of litchi trees are dark green, the growth are strong prosperous, maybe not necessarily to irrigation in dry winter.
In warm winter areas, for the early maturing varieties of litchi, when the dry winter (late autumn?), may also need to take a two-pronged flower technology:

- On the one hand need to irrigate for promoting flower, while the other hand need arid to control shoot growth, and control theirs vegetative growth.
3.5 Preliminary conclusions

- Dry winter irrigation is conducive Guiwei and Noumici litchi fruit set, increase production.
- But Taking into account water-saving irrigation, and considering the winter shoot of control and labor-saving and efficient cultivation factors, we should moderate irrigation in midwinter of lowest temperature, in dry winter year.
According to the results, projected for the crown size 4 × 4 m, medium litchi trees, the time of irrigation around early January, four times, intervals 7-10 days, each time per plant irrigation 150kg(liter) is appropriate, each plant amount to 600kg.
This test shows that too:

About different years, different regions, different Litchi species(variety), different crown size, different tree ages, different vigor, their appropriate amount of irrigation and irrigation timing, soil moisture and flowering and fruit set, etc.,

their definitive conclusions of irrigation role remain to be in further research.
Thank You !

❖ Thank You !