Evaluate the possibility of alternate bearing regulation of Siahoo mandarin (Citrus reticulata Blanco) by using pruning and girdling

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ABSTRACT: In order to evaluate the effects of pruning and girdling on regulating of alternate bearing in Siahoo mandarin (Citrus reticulata Blanco), an experiment was performed in a RCBD during four years with five treatments consist: low spring pruning, severe spring pruning, girdling, low spring pruning + girdling and severe spring pruning + girdling. Girdling and pruning performed in autumn and spring of ON years respectively. Evaluated characters were yielding, fruit weight and alternate bearing index (ABI). Results indicated pruning and girdling could be adjusted alternate bearing in this citrus cultivar. Evaluation of ABI also showed that using of low pruning + girdling in during of four years led to reduction of alternate bearing. Using of alone girdling or low pruning had no influence on the reduction of alternate bearing. In contrast, alone severe pruning or low and severe pruning + girdling could be lead to regulating of alternate bearing in Siahoo mandarin.

Keywords: Alternate bearing index (ABI), Fruit weight average, Siahoo mandarin, Yield.

INTRODUCTION

Alternate bearing is one of the disputable subjects in some of citrus cultivars. In alternate bearing, the yield of crops is high and small size and low quality. Produced fruits had unsuitable marketing-demand and do not earn proper economical benefit to the gardener. Furthermore, the existence of numerous fruits on the tree in ON year leads to severe weakness of the tree and quick evacuation of carbohydrates and nutrients. Consequently, in the next year, fruit set will be a few. Among the various species of citrus, alternate bearing in ‘Hamlin’ and ‘Valencia’ sweet oranges are low-important, in ‘Pineapple’ sweet orange and some grapefruits is medium to severe and in mandarin cultivars is a serious problem (Wheaton, 1996). An examination of ‘Valencia’ sweet orange trees by pruning of 5-10% shoots in the beginning of the June drop led to enhancement of shoot and summer growth but pruning at the end of the June drop did not change the number of shoots in each tree. Severe pruning decreased the number of fruits but average of fruit weight did not affect in any treatment. Pruning resulted to more penetration of light to tree crown. Pruning significantly decreased the harvested fruits in ‘Clementine’ trees. In the same study on 9-years-old ‘Ortanique’ tangor was indicated that moderate (remove of 19 kg shoot) and heavy (remove of 36 kg shoot) pruning had no influence on fruit number and average fruit weight. Therefore, the yield remained without change (Arbiza et al., 2000). Girdling means remove of a narrow whole ring of crown or shoot bark. Girdling operation has been many changes in citrus fruit quantitative and qualitative such as fruit-set enhancement in the OFF year (Agusti et al., 1992); increasing of fruit number on tree (Cohen, 1984; Monselis and Golshmidt, 1982); enhancement of fruit cracking; improvement of fruit color, sugar/acid ration, TSS/acid ratio and sugar (Simoes-Junior et al., 1990). Lahav et al. (1970) on evaluating the effect of girdling on crop production of Avocado found that girdling performance in the second and third year after girdling caused by reducing of yield than the control treatment. Meanwhile, repeating of girdling could be increasing of yield. Krezdorn and Wiltbank (1968) in annual girdling of ‘Orlando tangelo’ during 8 years found that fruiting and total produced fruits in girdled trees were more and more regular than non-girdled trees.

Girdling of ‘Fairchild’ mandarin in November, March and May months led to the production of the greatest yield in the first year. While girdling in March and may months caused to production of the highest
yield in second and third years. Enhancement of yield in March month was by enhancement of fruit number and in May month by fruit number and fruit size enhancement. From an economic point of view, girdling of ‘Fairchild’ mandarin in March and May months had more profit for the gardener. In relation to ‘Lisbon lemon’ like mandarin, girdling in November or November and March months led to more crop production after one year. Anyhow, these trees indicated alternate bearing cycle. In this relation, girdled lemons did not indicate any superiority that control trees (Wright, 2000). Mirsoleimani and Amin (2007) in evaluating the effect of girdling in ‘Mexican lime’ trees on fruit quality and quantity reported that girdling performance in full bloom stage prevented to fruitlets dropping because of carbohydrate accumulation in shoots and could be increased fruit-set percentage and consequently increase tree yield. Grigorian and Bidarigh Sharemi (2003) also recommended twin using of girdling and nitrogen fertilizer to increase of flower bud formation in ‘Golden delicious’ apple. Gholami et al. (2003) also advised girdling for increase of fruit-set on three grape cultivars. In order to, adjustment of alternate bearing in ‘Siahoo’ mandarin was performed present study by using pruning and girdling.

MATERIALS AND METHODS

This experiment carried out in randomized complete block design with five treatments and three replications and two trees in each replicate on ‘Siahoo’ mandarin trees that had alternate bearing during four successive years. For this purpose, was selected a garden having uniform 15-years-old trees in ‘Fareghan’ city (at a distance of 100 kilometers from Hajibad, Hormozgan). The treatments were consisting: 1) Low spring pruning with elimination of 10% shoots (The shoots elimination in the four sides of the tree with 15-20 cm length). 2) Severe spring pruning with elimination of 20% shoots. 3) Girdling in the end of the growing season (Two deep cuttings with 5 cm distance were done in phloem by using a disinfected cutter on shoots and the ring of bark was separated in the autumn). 4) Low spring pruning + girdling. 5) Severe spring pruning + girdling. All dried shoots removed by winter pruning in the first year. Pruning and girdling operation were done in ON years (2006 and 2008). At the end of each year, was recorded yield, average fruit weight and alternate bearing index (ABI) ([difference between the yield of two years/the sum of their yields] \times 100). Obtained data from four years of experiment analyzed as combined by using SAS 9.1 software and the means compared by using of Dancan’s new multiple range test (DMRT) in 5% level.

RESULTS AND DISCUSSION

Yield

In the evaluation of four years results were observed the highest yield in the second year (42.7 kg/tree) and the lowest in the fourth year (27.5 kg/tree) (Chart 1).

![Figure 1. Comparing the effect of treatments on yield](image)

The influence of pruning and girdling treatments on yield of ‘Siahoo’ mandarin trees in during of four years was completely obvious so that in the second year was observed significant increase and from the second to the fourth years significant decrease in the yield. Pruning and girdling treatments in the first year led to 23% increasing of yield in the second year. This trend in the third year 14% reduced. Reduction trend of yield continued 25% in the fourth year. Reduction trend of yield from the second year to later showed that pruning and girdling are able to improving of alternate bearing in this species of citrus (Chart 1).

Evaluating the effects of treatments on yield indicated that low and severe pruning (46.0 and 41.9 kg/tree respectively) had the greatest and severe pruning + girdling (22.3 kg/tree) the lowest yield in all four years (Chart 2).
Interaction between year and treatment showed the highest yield was observed in severe pruning treatment in the third year (69 kg/tree) and the least yield in alone girdling and/or severe pruning + girdling in the third year (3.1 and 4.6 kg/tree respectively) and also in severe pruning in the fourth year (12.5 kg/tree) (Table 1).

![Figure 2. Comparing the effect of year on yield](image)

**Table 1. Interaction between year and treatment on the yield (kg/tree)**

<table>
<thead>
<tr>
<th>Treatment Year</th>
<th>Low pruning</th>
<th>Severe pruning</th>
<th>Girdling</th>
<th>Low pruning + Girdling</th>
<th>Severe pruning + Girdling</th>
</tr>
</thead>
<tbody>
<tr>
<td>First (2006)</td>
<td>51.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>38.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>25.8&lt;sup&gt;d&lt;/sup&gt;</td>
<td>28.2&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Second (2007)</td>
<td>44.3&lt;sup&gt;e&lt;/sup&gt;</td>
<td>47.2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>57.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>35.2&lt;sup&gt;de&lt;/sup&gt;</td>
<td>29.3&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>Third (2008)</td>
<td>59.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>69.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.1&lt;sup&gt;j&lt;/sup&gt;</td>
<td>48.0&lt;sup&gt;e&lt;/sup&gt;</td>
<td>4.6&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fourth (2009)</td>
<td>29.5&lt;sup&gt;e&lt;/sup&gt;</td>
<td>12.5&lt;sup&gt;i&lt;/sup&gt;</td>
<td>30.0&lt;sup&gt;de&lt;/sup&gt;</td>
<td>38.2&lt;sup&gt;de&lt;/sup&gt;</td>
<td>27.2&lt;sup&gt;ef&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>*</sup>Means followed by similar letters are not significantly different (P ≤ 0.05) according to Duncan’s test (DMRT).

Alternate bearing was completely obvious in low pruning during four years. So that non-significant reducing of yield (13%) observed in the second year than the first year. This trend was increasing and then decreasing in the third and the fourth years (34 and 50% respectively).

In relation to severe pruning treatment, a changes trend of yield showed that the yield of the second year had non-significant increase (21%) than the first year. The increase trend of the yield significantly continued from the second year to the third year (46%). Therefore, increasing the yield observed during two successive years. Reduction of yield from the third to the fourth year (82%) indicated severe evacuation of tree from nutrients follow high-yield two successive years.

In alone girdling treatment was observed significant alternate bearing during four years. In the second year observed a significant increase of the yield (91%) than the first year. Significant reduction of the yield (95%) occurred from the second to the third year. This trend significantly increased (868%) from the third to the fourth year. There was no significant difference between the yield of the fourth and the first years. The positive influence of girdling on alternate bearing was completely obvious (Table 1). Mirsoleimani and Amin (2007) also reported the positive influence of girdling on the increase of the yield of ‘Mexican lime’ that regards to reduction of nutrient reserve in ON year leading to reduction of yield in the next year.

In relation to low pruning treatment + girdling, the yield of the second year non-significantly increased (36%) than the first year. Changes trend of the yield significantly increased from the second to the third year. Significant reduction of the yield was observed (20%) from the third to the fourth year. Adjustment of alternate bearing by using low pruning + girdling was completely obvious (Table 1).

In relation to severe pruning treatment + girdling, the yield of the second year non-significantly increased (4%) than the first year. This trend significantly decreased (84%) from the second year to the third year. Significant increase of the yield completely was obvious from the third to the fourth year. There was no significant difference between the first, the second and the fourth years (Table 1). Contrary to the findings of Krezdom and Wiltbank (1968) that found fruiting and total produced fruits in girdled ‘Orlando’ tangelo trees were more and more regular than non-girdled trees, in this study alone girdling had no influence on bearing regulation of ‘Siahoo’ mandarin but its combination to pruning could be regulated bearing.

**Fruit weight average**

Evaluation of four years results showed the highest fruit weight in the third year (125 g) and the lowest in the second year (82 g) (Chart 3).
There was significant difference between four years. Influence of pruning and girdling treatments on fruit weight in during of four years showed that fruit weight in the second year significantly decreased. Average fruit weight significantly increased from the second to the third year and decreased from the third to the fourth year. Changes trend of fruit weight in during of four years exactly was conversing of yield changes, so that average fruit weight decreased with the increase of the yield. The reason of this subject is enhanced of sink number than existing sources. The fruit weight average increased by reduction of the yield (Chart 3).

In evaluating the effect of different treatments on average of fruit weight, the least fruit weight observed in low pruning treatment + girdling (99 g) and the greatest in alone girdling treatment (123 g). In this relation, there was a significant difference between alone girdling treatment to other treatments but other treatments had no significant difference together (Chart 4).

Table 2. Interaction between year and treatment on fruit weight average (g)

<table>
<thead>
<tr>
<th>Year</th>
<th>Treatment</th>
<th>Low pruning</th>
<th>Severe pruning</th>
<th>Girdling</th>
<th>Low pruning + Girdling</th>
<th>Severe pruning + Girdling</th>
</tr>
</thead>
<tbody>
<tr>
<td>First (2006)</td>
<td>111&lt;sup&gt;a&lt;/sup&gt;</td>
<td>104&lt;sup&gt;b&lt;/sup&gt;</td>
<td>153&lt;sup&gt;c&lt;/sup&gt;</td>
<td>100&lt;sup&gt;cde&lt;/sup&gt;</td>
<td>103&lt;sup&gt;fg&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Second (2007)</td>
<td>77&lt;sup&gt;c&lt;/sup&gt;</td>
<td>97&lt;sup&gt;d&lt;/sup&gt;</td>
<td>65&lt;sup&gt;e&lt;/sup&gt;</td>
<td>85&lt;sup&gt;fg&lt;/sup&gt;</td>
<td>86&lt;sup&gt;fg&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Third (2008)</td>
<td>111&lt;sup&gt;c&lt;/sup&gt;</td>
<td>106&lt;sup&gt;b&lt;/sup&gt;</td>
<td>178&lt;sup&gt;a&lt;/sup&gt;</td>
<td>109&lt;sup&gt;c&lt;/sup&gt;</td>
<td>121&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Fourth (2009)</td>
<td>104&lt;sup&gt;cde&lt;/sup&gt;</td>
<td>99&lt;sup&gt;c&lt;/sup&gt;</td>
<td>97&lt;sup&gt;cde&lt;/sup&gt;</td>
<td>102&lt;sup&gt;fg&lt;/sup&gt;</td>
<td>105&lt;sup&gt;cde&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>Means followed by similar letters are not significantly different (P ≤ 0.05) according to Duncan’s test (DMRT).

**Alternate bearing index (ABI)**

ABI of the first year than the second year. The lowest ABI observed in severe pruning + girdling treatment (1.7%) and the highest in alone girdling treatment (35.8%). In this relation, there was only significant difference between these two treatments and other treatments had no significant difference together. ABI between the first and the second years were the lowest in severe pruning + girdling, low pruning and severe pruning treatments respectively (Table 3).

ABI of the second year than the third year. The lowest ABI observed in low pruning + girdling treatment (11.7%) and the highest in alone girdling treatment (89.8%). In this relation, there was a significant difference between alone girdling treatment to severe pruning + girdling treatment and other treatments had no
significant difference together. ABI between the second and the third years were the lowest in low pruning +
girdling, low pruning and severe pruning treatments respectively (Table 3).

Table 3. Effect of different treatments on alternate bearing index (ABI) in during of four years (%)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>1st year/2nd year</th>
<th>2nd year/3rd year</th>
<th>3rd year/4th year</th>
<th>1st year/4th year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low pruning</td>
<td>7.0^a</td>
<td>14.4^a</td>
<td>34.3^a</td>
<td>27.6^a</td>
</tr>
<tr>
<td>Severe pruning</td>
<td>9.5^a</td>
<td>18.5^a</td>
<td>68.8^a</td>
<td>52.6^a</td>
</tr>
<tr>
<td>Girdling</td>
<td>35.8^c</td>
<td>89.8^c</td>
<td>81.2^c</td>
<td>26.3^ab</td>
</tr>
<tr>
<td>Low pruning + Girdling</td>
<td>15.4^ab</td>
<td>11.7^a</td>
<td>11.7^a</td>
<td>19.0^a</td>
</tr>
<tr>
<td>Severe pruning + Girdling</td>
<td>1.7^b</td>
<td>72.0^c</td>
<td>71.2^c</td>
<td>7.4^c</td>
</tr>
</tbody>
</table>

^Means in each column followed by similar letters are not significantly different (P ≤ 0.05) according to Duncan’s test (DMRT).

ABI of the third year than the fourth year. The lowest ABI observed in low pruning + girdling treatment
(11.7%) and the highest in alone girdling treatment (81.2%). In this relation, there was a significant difference
between low pruning treatment to low pruning + girdling treatment and other treatments had no significant
difference together. ABI between the third and the fourth years were the lowest in low pruning + girdling and
low pruning treatments respectively (Table 3).

ABI of the first year than the fourth year. The lowest ABI observed in severe pruning + girdling treatment
(7.4%) and the highest in severe pruning treatment (52.6%). In this relation, there was a significant difference
between severe pruning treatment to low pruning + girdling and severe pruning + girdling treatments and
other treatments had no significant difference together. ABI between the first and the fourth years were the
lowest in severe pruning + girdling and low pruning + girdling treatments respectively (Table 3).

CONCLUSION

The influence of pruning and girdling treatments on yield of ‘Siahoo’ mandarin trees in during of four
years showed that pruning and girdling are able to improve of alternate bearing in this species of citrus.
Alternate bearing was completely obvious in low pruning during four years. In relation to severe pruning
treatment, observed enhancement of yield in during of two successive years. In alone girdling treatment was
observed significant alternate bearing during four years. The positive influence of girdling on increase of
alternate bearing was completely obvious. Many fruit trees such as grape (Gholami et al., 2003), apple
(Grigorian and Bidarigh Sharemi, 2003) and ‘Mexican lime’ (Mirsoleimani and Amin, 2007) using of girdling
has been caused to increase of fruit set that affect the yield of the next year and can be reduce of the yield
and thus the alternate bearing cycle continuously is repeating. Adjustment of alternate bearing by using of
low pruning + girdling treatment completely was obvious. In relation to severe pruning + girdling treatment,
regards to not be a significant difference between the first, second and fourth years in the viewpoint of yield
can be elicited that this treatment can be decreased alternate bearing in long-time. Evaluation of the
alternate bearing index showed that using of low pruning + girdling caused by reduction of alternate bearing
other than treatments in during of four years. Besides alone girdling treatment had the lowest influence on
the reduction of alternate bearing. Total can be concluded that using of alone girdling and/or alone low
pruning have no influence on alternate bearing reduction. Against, alone severe and/or low and severe
pruning + girdling can be regulating alternate bearing.

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