Effects of Different Rejuvenation Pruning Methods and the Best Time for Utilizing Urea Fertilizer on the Some of Growth Characteristics of Olive

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ABSTRACT: Olive trees gradually produce more wood with aging; and thus, the proportion of leaves to wood reduces and this as will causes a performance reduction, fruit quality degradation and an intensified alternate-bearing. From that time on, the rejuvenation program should be initiated. This study was conducted from February 2011 to July 2013, in an old olive grove located in Tarom city, Zanjan province, Iran. The experiment was performed in the form of a randomized complete block design, considering two factors of rejuvenation pruning techniques at four levels and the time of utilizing urea fertilizer in four stages and with three replications. The results of the first and second years showed that periodic and continuous pruning methods had the maximum length and weight of new shoot growth in the first and second years; this suggests a significant difference with the other two methods of perfect – topping and traditional pruning. Also, the continuous pruning method had the most amounts of the above features in the first and second years with an average offset length of 137.12 cm, an average offset number of 54.45 and an average offset weight of 6.15 kg. According to the results, continuous and periodic pruning were decided as the best methods for rejuvenation old groves.

Keywords: rejuvenation pruning, periodic pruning, continuous pruning, and perfect – topping

INTRODUCTION

Olive is one of the most important horticultural products in Iran. Despite its long history, the development of olive cultivation has become a center of attention in just the past two decades. The development of olive cultivation has started in the year 1993. This project is being implemented in different provinces where it is possible and the climatic conditions are suitable for olive trees (Anonymous, 2010). Three types of pruning including training, pruning for crop and rejuvenation pruning, are selected and executed according to the age and developmental stages of olive trees. Rejuvenation pruning is performed on old trees and every 20 to 25 years in many olive-rich Mediterranean countries. In the case of Iran, as a result of unfamiliarity with the principles of rejuvenation pruning, the fruiting of old orchards has reduced and maintaining them is not economical. Old olive groves are often located in olive producing areas such as the provinces of Qazvin, Zanjan, Guilan and Gorgan. The area of these groves under cultivation reaches about 5,000 hectares (Zeinanloo, 2001). Olive trees gradually produce more wood with aging; and thus, the proportion of leaves to wood reduces and this as will causes a performance reduction, fruit quality degradation, and an intensified alternate-bearing. The limited vegetative growth of current year branches, small and badly colored leaves and sometimes, the falling of leaves from branches are signs of aging. In fact, from this time on, the rejuvenation program must be initiated. There are many dormant buds in the old parts of olive trees which can grow like normal vegetative buds and even revitalize the tree if provoked by proper pruning. This capability is the very key to the success of rejuvenation pruning (Sadeghi, 2002).

Maczulajtys et al. (1999) conducted a study on the seasonal changes of starch and soluble sugars and the effects of pruning on the spatial and temporal distribution of non-structural carbohydrates in cherry trunks, and showed that the levels of soluble sugars are high in the upper parts and low in the lower and middle parts compared to unpruned trees one month after pruning. Pruned trees were marked by a visible increase of soluble sugars in the mid and lower parts of the trunk during spring.

Zare (2007) examined the effects of pruning on the quality and quantity of the sabz cultivar of dried ficus during a three-year period and showed that the severe winter pruning of the claws, together with winter perfect- topping, causes the longitudinal growth of branches significantly more than light winter pruning or traditional treatments of the claws do. But with green summer pruning, branch longitudinal was reduced which is helpful to keep the shoots small and efficiently use the soil moisture in dryland conditions. It also became clear that severe winter pruning of the claws, together with summer green pruning, increases the diameter of the dried fruit.

Asadi & Kangarshahi (2011) carried out a research to reduce the alternate-bearing of Onsho mandarin fruit by managing the consumption of nitrogen and pruning in the east of Mazandaran province and concluded that the foliar application of urea, besides autumn nitrogen consumption and spring pruning, can virtually eliminate the alternate-bearing cycle of fruit.

Haloxylon shrubs are used as one of the most adaptable species for sand stabilization in arid regions, but they wither and
dry over time. Baghestani et al. (2004), in a study on the effects of two concentrations of 125 and 250 trees per hectare and four types of recision (at the floor level, at the height of 35 cm and 70 cm, and control, i.e. without recision) on the growth of old Haloxylon shrubs in Ashkezar area of Yazd province during a six-year period, suggested that reducing the density to 250 trees per hectare had no significant effect on the growth of shrubs. It also became clear that applying recision has a positive impact on the growth of shrubs and that recision at the height of 35 cm is superior to the other methods. Shamszadeh & Baghestani (2003) examined the impact of pruning on the congestion of important pests on old Haloxylon shrubs of Yazd province and concluded that pruning treatments have a significant effect on the number of psyllidaes and leafhoppers of Haloxylon shrubs. The number of psyllidaes and leafhoppers, in the fourth year and in the final year of the study in the control treatment, were significantly different: The number for recision at the floor level was more than that of recision at the heights of 35 and 70 cm. The increase in the number of psyllidaes and leafhoppers in pruned shrubs, especially with recision at the floor level, indicates that sucking pests prefer lush green plants.

As the development of new olive groves with reasonable cultivars in the country is important, restoration of old plantations and keeping them fertile are also important. In old olive groves, due to the high density of trees and a lack of proper pruning, the canopy of the trees compete with each other to achieve necessary light and thus, the trees grow very high. Also, due to the lack of light in the lower branches and a lack of pruning, these branches wither and this causes the weakening of the trees and reduces their yield. Harvesting costs increase because of the need for a large number of workers and the vulnerability of workers increase during harvest time (Zeinanloo, 2011). So far, no research project has been carried out in Iran on rejuvenation pruning of olive trees and subsequent urea fertilization. Therefore, conducting research projects on rejuvenation pruning of olive trees is important.

Nitrogen is an essential element for the growth of olives, and applying the optimal management of this element in olive groves is necessary. The amount of Nitrogen directly influences the vegetative growth, fruit formation, shoot growth and yield of tree. Even, it is mentioned in some sources that nitrogen is the most important among the many environmental factors that affect fruit formation (Taheri, 2007; Malakooti & Taheri, 2000). Thus, using nitrogen for supplying pruned trees can aid the regrowth of branches and the development of canopies.

MATERIALS AND METHODS

This study was conducted in an old olive grove with 30 years old trees in Guilanksheh Village of Tarom city, Zanjan province. The trees were set at a distance of 7 meters. The grove was located at 49° 6' longitude and 36° 45' latitude. Olive trees studied in this research were the Zard cultivar. The Zard cultivar is the local cultivar of Tarom and covers the largest part of its surface under cultivation (Anonymous, 2006).

A factorial experiment with 16 treatments and three replications in a randomized complete block design was implemented for analyzing the two factors of pruning techniques - including: regular pruning, the removal of broken and entangled branches, continuous pruning, periodic pruning and tree perfect -topping – and the time of applying 900 kg of urea fertilizer (based on current fertilizer recommendations in the area) - including in March; in March and May; in March, May and July; and no fertilizer (control).

In the periodic rejuvenation method, the recisions are applied periodically on old trees. In the perfect-topping method, all tree trunks are eliminated from the 1.5 to 2 meters high. Two or three years after severe pruning, the selection of new arms that shape the form of the canopy is essential. After four or five years, young canopies become ready for economical productivity. In continuous pruning method, Treeis divided into two parts.In the first year, the initial part of the tree (from 1.5 to 2 meters high) should be pruned. In the second year, there is no pruning; but in the third year, the secondpartof the tree should be topped (Zeinanloo, 2011).

In February, olive trees were pruned in four ways. In March, 900 g of urea fertilizer was used for group of trees based on the experimental design. In July and May 2012, the same amount of urea was used for another group of olive trees. In February 2012, the continuance of four rejuvenation pruning techniques were performed. Based on the experimental design, 900 g of urea was used for each tree in three periods: March 2012; July and May 2013. During field operations, the number, length and weight of offsets and the number, length and weight of new shootgrowthwere measured. After tabulating the data in Microsoft Excel and gaining the parameters, the analysis of variance was performed to the obtained data at 0.05 and 0.01 levels using the SAS software and treatment means were compared using the Duncan's multiple range test.

RESULTS AND DISCUSSION

The length, number and weight of offsets

Analysis of variance of the length, number, and weight of offsets in the first and second years of pruning showed that pruning methods had a significant effect on the length, number and weight of offsets at the 0.01 level; while the length, number and weight of offsets were not affected by the times of fertilizer utilization in the first and second years of pruning. The interaction effect of pruning techniques and fertilizer utilization time had a significant effect on the length and number of offsets in the first and second years of pruning at the 0.05 level and on the weight of offsets at the 0.01 level (Table 1).

Mean comparison results of the length, number and weight of offsets in the first and second years of pruning, using different pruning techniques and in different times of fertilizer utilization, showed that the continuous pruning technique had the highest values with an average offsetlength of 137.12 cm, offsetnumber of 54.45, and offsetweight of 6.15 kg in the first and second years of pruning. While traditional pruning had the lowest values with an average offsetlength of 19.11 cm, offsetnumber of 4.68, and offsetweight of 1.63 kg (Table 2).
The length, number and weight of new shoot growth

Analysis of variance of the length, number, and weight of new shoot growth in the first and second years of pruning showed that pruning methods had a significant effect on the length, number and weight of new shoot growth at the 0.01 level in the first and second years of pruning; while the length and weight of new shoot growth were not affected by the times of fertilizer utilization. Fertilizer utilization time had a significant effect on the number of new shoot growth at the first and second years of pruning at the 0.01 level. The interaction effect of pruning techniques and fertilizer utilization time had a significant effect on the number and weight of new shoot growth at the 0.01 and 0.05 levels in the first and second years of pruning (Table 1).

Table 1. Results of analyzing the traits measured for offsets and new shoot growth in the first and second years of pruning

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Degrees of freedom</th>
<th>Number of offset</th>
<th>Weight of offset (kg)</th>
<th>Length of offset (cm)</th>
<th>Number of new shoot growth</th>
<th>Weight of new shoot growth (kg)</th>
<th>Length of new shoot growth (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pruning techniques</td>
<td>3</td>
<td>14.02</td>
<td>46.79</td>
<td>29988.74</td>
<td>8.72</td>
<td>31.99</td>
<td>40413.91</td>
</tr>
<tr>
<td>Time of fertilizer utilization</td>
<td>3</td>
<td>0.49 'm'</td>
<td>0.47 'm'</td>
<td>1377.10 'm'</td>
<td>0.35 'm'</td>
<td>1.04 'm'</td>
<td>1542.55 'm'</td>
</tr>
<tr>
<td>Coefficient of variation</td>
<td>9</td>
<td>1.30 'm'</td>
<td>2.03 'm'</td>
<td>1373.81 'm'</td>
<td>0.19 'm'</td>
<td>2.18 'm'</td>
<td>1472.41 'm'</td>
</tr>
</tbody>
</table>

* and ** stand for significant at the 0.05 and 0.01 levels, respectively. "ns" stands for non-significant.

Table 2. The comparison results of the treatments mean in the measured factors

<table>
<thead>
<tr>
<th>Pruning techniques</th>
<th>Weight of new shoot growth (kg)</th>
<th>Length of offset (cm)</th>
<th>Weight of offset (kg)</th>
<th>Number of offset</th>
<th>Length of new shoot growth (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periodic</td>
<td>3.40 a</td>
<td>106.31 b</td>
<td>5.37 b</td>
<td>34.3 a</td>
<td>171.54 a</td>
</tr>
<tr>
<td>Continuous</td>
<td>3.97 a</td>
<td>137.12 a</td>
<td>6.15 a</td>
<td>54.45 a</td>
<td>174.81 a</td>
</tr>
<tr>
<td>Perfect-Topping</td>
<td>1.46 b</td>
<td>89.68 b</td>
<td>4.38 c</td>
<td>14.08 b</td>
<td>106.39 b</td>
</tr>
<tr>
<td>Traditional</td>
<td>0.48 c</td>
<td>19.11 c</td>
<td>1.63 d</td>
<td>4.68 c</td>
<td>52.92 c</td>
</tr>
</tbody>
</table>

The means with same letter in each column are not significantly different.

Mean comparison results of the length and weight of new shoot growth in the first and second years of pruning, using different pruning techniques and in different periods of fertilizer utilization, showed that the continuous and periodic pruning techniques had the highest length and weight and were significantly different from the other two methods: perfect-topping and traditional pruning. While traditional pruning had the lowest values with an average new shoot growth length of 52.92 cm, and an average new shoot growth weight of 0.48 (Table 2).

Given that in the continuous method, urea fertilizer utilization had a significant effect on the number of new shoot growth but not on their length, it seems that the effect of urea on rejuvenated trees in this method was more of activating the dormant shoots rather than affecting their length. In the continuous pruning method, as in the periodic method, given that most of the tree trunk has leaves and branches that photosynthesize and provide nutrition. Therefore, in comparison to perfect-topping, this method provides the reserves for shoots and offsets more easily. It seems that urea fertilization and the reserves of pruned trees in different pruning techniques tend more to affect new shoot growth and offsets rather than to affect suckers.

CONCLUSION

The continuous pruning technique had the maximum length and weight of new shoot growth, the maximum number, length and weight of offsets in the first and second years of pruning, while traditional pruning featured the least amounts of the above characteristics. According to the results, continuous and periodic pruning techniques proved most efficient to rejuvenate old groves.

REFERENCES