New mechanical methods and treatments for controlling of leafy mistletoe (Loranthus europaeus jacq.) on Persian Oak trees (Quercus persica)

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ABSTRACT

Loranthus europaeus is a semi-parasitic plant lives on Persian oak trees in the Zagros forests and it has caused damage to them. In order to evaluate the performance of five mechanical treatments; Glue stick, clay, black plastic, natural color and control treatment for controlling mistletoe and choose the most appropriate treatment among them, Hyanan oak forested area located in north of Ilam province was selected. A research site was selected at altitude of 1800-2000 m above sea level in the study area. For each treatment 3 Persian oak trees and in total 15 trees were selected. Implementation and monitoring of treatments was done during four years. Results showed that Glue stick and clay were 100% successful in controlling of mistletoe, but efficacy of black plastic and natural color was 30% and 0%, respectively. Black plastic and natural color didn’t have a good performance in controlling mistletoe, and the performance of black plastic was better than that of natural color. The control effects of natural color and somewhat black plastic on mistletoe were weak and temporary, and their efficacy were disappeared after sometime so mistletoe became green and revived again. Based on the results, it can be concluded that the removal of infected branches and caulking the cut surfaces with clay or Glue-stick cause eliminate the mistletoe and prevent its re-establishment on the treated branch. These two treatments are cheap and easy to accomplish.

Keywords: Loranthus europaeus, persian oak, treatment, mechanical control, Ilam.

1. Introduction

Loranthus europaeus is semi-parasitic plant which lives on Persian oak trees (Sabeti, 1992; Mozaffarian, 2008). This mistletoe gets completely its nutritional needs from host plant due to its semi-parasitic behavior. In stage of leaf production it can provide its needed organic materials by photosynthesis, but is still dependent on the host plant for water and minerals (coder, 2004). It also is a real mistletoe species (leafy) that severe infection to it leads to gradual decline of infected trees (Blanchard and Tatar, 1997). Losses due to this plant on oak trees in Zagros forests have led to implementations for its controlling. Mistletoe controlling has done every year by responsible organs, but it has not with any successful result due to the lack of technical principles in their operations.

In the common mechanical control method the cut surface of infected branches is not covered after cutting operation and it may be a place for regrowth of prior mistletoe or growth of new mistletoe shrub. Hadfield and Flanagan (2000) have stated that mistletoe pruning of infected branches may be cause of wood-borer beetle attacks. For this, moreover removal the infected branches, the cutting place of them could be covered by treatments such as Glue-stick or clay. While, the wounds of cutting places would be heal and contamination penetrating into these places or mistletoe seed establishment on these places would be prevent. In addition, there are
treatments such as natural color and black plastic as sunlight exclusion treatments which are studied in this research. These treatments work by prohibiting photosynthesis and vegetative and reproductive activities of mistletoe by opaque coverings. In this group of treatments, mistletoe shrubs will not be removed, but the branches and leaves of the mistletoe are covered with black plastic or natural colors so sunlight energy could not be reach to the mistletoe leaves. For better control managing of mistletoe several researches have been done across the world and several mechanical, chemical, and biological control methods have been tested which is referred to some of them. Watson and Martinez-Trinidad (2006) evaluated the efficacy of several methods to control Phoradendron tomentosum in Ulmus crassifolia. Removal of the branch 30.5 cm (12.2 inch) below the mistletoe, removal of mistletoe, and treating the branch bark with naphthalene acetic acid (NAA) or a caulking compound in which mistletoe was removed resulted in reduced regrowth of the ectophyte (>90%) after 5 months. The use of growth regulator and herbicides (ethephon, 2, 4-D, and glyphosate) did not provide acceptable control of mistletoe. After 29 months, only removal of the branch and caulking over the bark after mistletoe removal demonstrated a significant long-term effect on mistletoe mortality (40% and 57%, respectively). The use of NAA and light exclusion (black latex paint) reduced the re-sprouting of mistletoe by 50% after 8 months, but this effect diminished over time. However, 16 months after application, NAA and paint significantly reduced regrowth compared with removing mistletoe alone.

Forge–Zirkler (2008) studied responses of mistletoe infected trees to pruning. In this study, infected trees were pruned with three intensities of complete prune, Two-third prune and one-third prune. Results showed that the complete pruning and two-third pruning methods produced the best answer in the trees. But, one-third prune produced no significant difference in response when compared with the experimental control, after four years.

Baltazar et al (2012) investigated the mechanical and herbicide control methods against Viscum album on some species of Crataegus. Two types of mechanical removal were tested: mistletoe bushes were removed without the branch of host tree and including the host’s branch. Mechanical removal was successful only in cases when the mistletoe shrubs were removed with host branches. Also combined removal as removal of mistletoe bushes without host branches and covering surface with MCPA and glyphosate agents was done. They observed new mistletoe shoots three months after the treatment of glyphosate agent, while in case of MCPA agent no sprouting was noticed.

Zarugh et al. (2013) examined the mechanical control of Tapinanthus globiferus on lime and guava garden tree species in Sudan. Control methods include severe pruning, regular pruning using long handled shears and traditional pruning by using logging axe. In conclusion, severe pruning and regular pruning using long handled shears were found to be effective in controlling the parasite in guava and lime trees.

By investigation of treatments and presentation of appropriate methods or guidelines to improve the efficiency of mechanical control methods of mistletoe, the modified mechanical control method can be perform in the extensive Zagros forests and Besides saving human and financial costs, the health of forests is supplied. Given that since the effects of Glue stick and clay treatments on improving the mechanical control of mistletoe are not checked yet, so this study performed with aims; 1- to investigate the performance of Glue stick, clay, natural color and black plastic, 2- to achieve the results of comparison among the treatments and 3- to determine the best treatment among them for better removal of mistletoe and reduction the likelihood of its re-establishing.
2. Materials and methods

2.1 Study area

A part of the Hyanan forest on the southern slopes of Manesht mountain located in north of Ilam province in southwestern of Iran were selected for this study (Figure 1). This area is one of the most polluted areas to mistletoe in the Ilam forests. Therefore it was suitable detected to study.

![Study area and location](image)

Figure 1: The study area and its location on the map of Ilam province

2.2 Research method

Five treatments were examined in this research including: 1- Control treatment 2- Glue stick 3- Clay 4- Black plastic 5- Natural black color. For this research an area at an altitude of 1800-2000 meters above sea level was determined. Three replicate oak trees were selected for each treatment. Around the treated trees, the other trees were cleaned in a strip width of 50 m to avoid seeds dropping and sprouting into the test area. This study was conducted in a completely randomized design. Implementing of treatments and their monitoring was accomplished over 4 years. In the first year of study, the infected branches of trees of the first three treatments were removed at 30 cm below the mistletoe and the cut places of the branches were covered with Glue stick and clay in the second and third treatments. On the trees of fourth treatment the shrubs of mistletoe were covered with black plastic and spraying the shrubs of mistletoe with natural color were done for treated trees of fifth treatment.

For treated trees of control treatment, the removed branches were not covered. The treated trees were assessed during the second and fourth years of experiment. During the evaluations, the crown condition of each treated tree in terms of re-sprouting of removed mistletoe for treatments 1, 2 and 3, and returning of un-removed mistletoe on the treated branches for treatments 4 and 5, and establishment of new mistletoes on the other branches of the treated trees were assessed.

2.3 Data Analysis

After collecting the data, the condition of each treatment was analyzed. Comparison of efficacy among treatments in terms of Mistletoe controlling amount was done. Quantitative data was checked for normality and homogeneity using tests of Kolmogorov-Smirnov and
Leven. One-way Anova was used to determine significant differences among the treatments and Duncan test was used to compare means of treatments. The establishment amounts of new mistletoes on other branches of the treated trees were counted. To achieve the needed results excel and spss soft wares, charts and statistical analysis were used.

3. Results

3.1 Re-establishment condition of treated mistletoes on trees

In this survey, re-sprouting of removed mistletoes on the treated branches by clay and Glue stick, and viability and vitality status of mistletoe plants treated by plastic and natural color treatments were recorded. Re-sprouting of mistletoe was not observed on the treated branches by clay and Glue stick. But some of mistletoe plants were dried on the branches treated by plastic and natural color treatments and most of them were not dry or nearly dry and after two months they were green and came back (Table 1). Notably, one of the treated trees was died due to the prior pressures of mistletoe on the tree and its weakening during the recent drought.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Mistletoe re-establishment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glue stick</td>
<td>Mistletoe regrowth was not seen</td>
</tr>
<tr>
<td>Clay</td>
<td>Mistletoe regrowth was not seen</td>
</tr>
<tr>
<td>Black plastic</td>
<td>Mistletoes have some green again</td>
</tr>
<tr>
<td>Natural color</td>
<td>Mistletoes are mostly green again</td>
</tr>
<tr>
<td>Control</td>
<td>in most cut places, Mistletoes are not green</td>
</tr>
</tbody>
</table>

3.2 Performance of treatments in mistletoe controlling

Results indicated that mistletoe controlling successfully was done in 100% of treated trees by clay and Glue stick. 1 year after application with black plastic 60% of treated mistletoes were controlled, but after some time, it was observed that some mistletoe plants treated by plastic were not completely dried and gradually became green and came back, so after 3 years only 30% of them were controlled successfully. Also, all mistletoe plants treated by natural color were came back (Figure 2).

4. Establishment condition of new mistletoes on treated trees

Results showed that during 3 years after application, new mistletoes were emerged on another branches of treated trees (table 2). Also results showed that on some of treated trees the number of new mistletoe shrubs was increased with increasing the time.

5. Discussion

*Loranthus europaeus* grows on Persian oak trees as semi-parasite and uses water and minerals from tissues and organs of host tree. This life style of mistletoe has made excessive
New mechanical methods and treatments for controlling of leafy mistletoe (*Loranthus europaeus* jacq.) on Persian oak trees (*Quercus persica*)

stress on oak trees in recent years, because in recent years extensive tree mortality has been occurred following severe droughts in Zagros forests especially on oak trees.

![chart](chart.png)

**Figure 2:** Means Comparison of mistletoe mortality among treatments separately in first year (black color) and third year (white color) after application of treatments. Results of kruskal wallis test for data of 2011 and 2013 years (chi2=14, df=4, sig= 0.007).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Final number of mistletoe shrubs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
</tr>
<tr>
<td>Glue stick</td>
<td>1</td>
</tr>
<tr>
<td>Clay</td>
<td>1</td>
</tr>
<tr>
<td>Black plastic</td>
<td>0</td>
</tr>
<tr>
<td>Natural color</td>
<td>0</td>
</tr>
<tr>
<td>Control</td>
<td>2</td>
</tr>
</tbody>
</table>

In this condition, mistletoe by consuming water and minerals of host tree makes extra stress on the host tree and causes the host tree die as soon as against severe drought stress. As a real example, one of the treated trees in study area was died due to the prior pressures from mistletoe and excess pressures of recent droughts. Tainter (2002) and Christenson et al. (2003) found that if the environment condition is appropriate for host species and habitat is rich, the host can tolerate mistletoe for long periods and will coexist with it, but if the host experiences more stresses such as drought, invasion of pests and diseases and etc..., it can not tolerate and at last die.

In such condition, any action to reduce stress on trees can aid to strengthening their resistance against dieback and death due to recent droughts. Mechanical control against mistletoe can help to reduce its Pressures on oak trees. Reid et al (1994) found that trees infected with *Viscum album* have more mortality than trees which their mistletoes have been removed (Baltazar et al, 2012). Calder et al. (1983) demonstrated that the direct methods such as cutting of infected branches or removal of infected trees are still of functional methods used to control mistletoe (Baltazar et al, 2012). Balthazar et al. (2012) indicated that removal of mistletoe with infected branches of host trees has been successful in mistletoe controlling. However, some researches have shown that removal of mistletoe-infected branches may result in attack and penetration of beetles (Hadfield and Flanagan, 2000). So the modified and multiple mechanical Cuts can raise the efficiency of control and prevent regrowth of mistletoe. In other words, the mechanical removal of infected branches with caulking the cut
surfaces can be combinational and complete technique to control of mistletoe. Because, by covering of cut surfaces will prevent from entering of pests and diseases to the tree. Moreover it will prevent from re-establishment of mistletoes in cut places which are vulnerable. Several researchers including Lichter et al. (1991), Watson and Martinez-Trinidad (2006) and Baltazar et al. (2012) in their investigations reported the using combined and complete mechanical treatments for controlling mistletoe. Results of present research showed that Glue stick and clay treatments well have been successful in controlling mistletoe. But the natural color and black plastic treatments did not have notable efficacy in this case. Watson and Martinez-Trinidad (2006) found that removal of mistletoe and treating the branch bark with a caulking compound resulted in reduced regrowth of the ectophyte (>90%) after 5 months. After 29 months, only removal of the branch and caulking over the bark after mistletoe removal demonstrated a significant long-term effect on mistletoe mortality (40% and 57%, respectively). Also they reported that Using of light exclusion (black latex paint) reduced the re-sprouting of mistletoe by 50% after 8 months, but this effect diminished over time.

Natural color and black plastic work by prohibiting photosynthesis of mistletoe by opaque coverings. These treatments are used for preventing the absorption of light by mistletoe and its using in photosynthesis and vegetative and reproductive activities. It is natural that if does not reach enough light to the leaves of mistletoe, the vital activities of this plant like any other plant has been compromised and the continuation of these preventions can resulted in its death. Advantage of plastic is in prohibiting of light. In addition, due to its black color and its use in the hot season, excessive heat is produced surrounding mistletoe shrub that will accelerate its drying. Because of these two advantages of plastic, some of the mistletoe plants were dried. However, the plastic treatment had disadvantages such as its low resistance against the hot sun of summer. Furthermore, permanent winds are always blowing in the study area. Plastics do not have any resistance against wind and easily torn by the wind and are removed surrounding of mistletoe plants. If this mistletoe is not completely dried, it can regrowth by absorption of water and minerals from the host tree and comeback in the same year or next year. So some of treated mistletoe plants were came back and revived.

In this study, performance of some treatments was changed due to the influence of other factors. Related to the black plastic treatment was seen that some plastics were torn by shepherds and even by some hikers because of various reasons such as curiosity and etc. It is interesting that despite the recovering of mistletoe by plastic, it was observed that some of them were torn again. Thus, this procedure had a negative impact on the performance of plastic treatment and thus it did not show good performance. It seems that even the positive performance of plastic, its advising to apply is not reasonable. Because operationally it is difficult and can not be applied in the large fields of Zagros forests.

Based on the results, the natural color treatment did not show any success. Basically, mistletoe leaves are smooth and glossy, and spraying the branches and leaves of it with natural color is problem, time consuming and frustrating. Because color spraying should be done in several consecutive times, so that it can fully prevent the absorption of light by mistletoe. In addition, some of mistletoes are located in upper parts of the crown, even at the tip of thinner branches of host tree. In this condition color spraying will not done correctly. Time consuming, being tedious, require to frequent practice of color spraying and presence of some mistletoes on thinner branches and upper parts of the crown are some factors that have negative impacts on the performance of natural color treatment. These properties indicate the impossibility of this treatment to recommend.
Results of present research showed the successful performance of clay and Glue stick treatments. These treatments work by prohibiting entrance of pests and diseases, regrowth of mistletoe and reestablishment of mistletoe seeds by covering the cut surfaces of treated branches. Clay is frequent and accessible for application in forest and its requiring to water, for making the clay, is low. Glue stick is not expensive and do not affect the health or condition of the host tree. Also these two treatments are easy to apply. Thus these treatments are recommended for mistletoe controlling by the executive organs.

It is Notable that, new mistletoes were grown on the other branches of treated trees. Despite the mistletoe clearing of adjacent trees in a strip width of 50 meters around the treated trees, some of treated trees were infected to new mistletoes during 3 years following the application of treatments. These results show that establishment of new mistletoe shrubs in many cases is by birds. Since the establishment of conservative buffers, the new mistletoe shrubs have been observed on treated host trees. Also mistletoe seeds are not light and do not spread by wind and some of them fell due to their own weight from the upper parts of crown and stuck in the lower branches and grown at a suitable time. However, in this study, all mistletoe shrubs were removed before ripening their fruits and were taken out of the field. So the only reason for the establishment of new mistletoe shrubs can be the presence of birds. This conclusion is consistent with remarks of Aukema and Martinez del (2002). They found that the presence of birds complicates the control of mistletoe plant.

So for preventing the establishments of new mistletoe plants can be recommended that moreover using the successful control treatments, operations should be performed in large-scale and before ripening mistletoe fruit and all removed mistletoe shrubs should be burned or taken out of the field. However, respected to the nutritional characteristics of mistletoe Leaves, it can be used for livestock grazing (Valizadeh et al, 2011).

6. References


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