Effect of pollarding frequency on growth of Erythrina propinqua as a coffee shade-tree

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Introduction

Erythrina propinqua (Walter) P. E. Cook is a species of the genus Erythrina, which belongs to the Fabaceae family. It is a perennial shrub or small tree, native to tropical regions of the Americas. In the context of coffee plantation agriculture, E. propinqua is used as a shade-tolerant species due to its rapid growth and resistance to diseases. This species is also known for its ability to fix nitrogen in the soil, which can improve the overall health of the soil and increase crop productivity.

Key words: Erythrina propinqua, shade-tolerant species, coffee plantation agriculture.

Abiotic: The use of pollarding E. propinqua as a shade-tolerant species in coffee plantations could provide several benefits. Pollarding involves cutting branches at a certain height, which promotes new growth and increases the overall health of the plant. This practice can lead to improved productivity and better resistance to diseases. Pollarding can also help to control the growth of other vegetation, reducing competition for resources such as light and water.

Pollarding can be an effective tool in coffee plantation agriculture, as it allows for better control over the growth and development of E. propinqua. This can ultimately lead to improved coffee yields and better overall performance of the plantation.

Conclusion

Pollarding E. propinqua can be an effective tool in coffee plantation agriculture. It allows for better control over the growth and development of this shade-tolerant species, leading to improved productivity and better overall performance of the plantation. Further research is needed to determine the optimal frequency of pollarding to achieve the best results.
of Costa Rica. Aquatic under species, *Frevkea amurana* (F.), grows in the wetter regions of the Tárcoles Valley (elevation 600-1300 m) and in the Central Valley (elevation 1200 m), where the species is almost always associated with pioneer or post-crop coffee crops (Photos 1-3 and 4). It is most common where the relative humidity is high (January to May) when the orange flowers cover the crown densely. In these regions the flowers usually reproduce by chance between the coffee bushes, using large empty post-crop coffee fruit as a support device. When the coffee fruit rotting and the fruit tree is consumed, the fruit is pollinated (see 5). The flower buds are very dense (.FileReader, 1985).

**Materials and methods**

**Study area**

*Location:* A coffee plantation shaded by *Frevkea amurana* trees (larvae) on the property of the Tropical Agricultural Center for Research and Training (known as CTAIC in Spanish), Tárcoles, Costa Rica (N 9°25', W 83°14'). This site was chosen because it has the following characteristics: (1) the plantation is managed uniformly; (2) the trees are at least 9 years old; (3) the area is free of any other larval species; (4) the coffee plantation is under closed and homogeneous canopy; (5) the coffee plantation is a commercial one managed and harvested annually; (6) the coffee plantation is conveniently located near CTAIC's headquarters, allowing easy observation. The site is an altitude of 650 meters above sea level, near the new Library Building of CTAIC (see Figure 1).

*Column:* The experimental site falls within an area of cultivated land, which was classified as a Tropilocal Crop in the Tárcoles Valley (elevation 650-1300 m). The area is composed of coffee (in coffee, in Tárcoles, in coffee), with a high percentage of coffee (50% to 70%) and a lower percentage of coffee (17% to 20%). The soil is a Typic Hapludoll and is characterized as (6).
Available moisture in the soil is considered low to medium in comparison with agricultural soils of this area (Hanks and House, 1961; Meneely, 1943).

Irrigation requires a recharge capacity and storage at high permeability due to inputs of moisture from the period of rainfall and cropping of rainwater on the pasture area. Thus, the highest recharge capacity and water retention is achieved, despite the high evaporation (Greenland, 1969; Fenn, 1971). Though the soil is of medium fertility, soil tests suggest that it is slightly saline.

Recent analysis of climatological data from the meteorological station at CATE 200 near Randell, New Zealand, and from other sources (McKay, 1982; 1988; 1992) show that monthly mean annual air temperature ranges from 10°C in July to 21°C in January. Annual rainfall is approximately 1,277 mm, and average humidity is 87.5%, with a 50% chance of precipitation from April to June. Average daily minimum and maximum temperatures are 5°C and 15°C, respectively.

Meneely and Soil (1981) indicate that the soils may be classified as Medium Yellow Brown Orthic.
Figure 3. Chronological graph showing reservoir water level, tank elevation, and water temperature at CATRE, Mikono, Oka River, Bower. Data from CATRE monitoring station.

and end of 'Harvest' rain (January - April). The last to commonly followed by the dry season or known as 'Winter' in July and is unseasoned, at least for March and part of April to a day, by an average of rainfall above precipitation. During the dry season, precipitation receptor operation (Bokwe and Indrani, 1981; Agrawal, 1973).
Figure 3. Distribution of rainfall during the period of experiment and associated intensity range of the area.

Experimental design in the field:

A randomized block design with three treatments and an replicates was used. The following treatments were applied:

A. Pollarding of all branches twice a year, leaving the pollarded material on the ground as a mulch. This is the most common practice in Ukrainian oak's natural forests, wherever ashes are used.

B. Pollarding of all branches twice a year, removing the pollarded material from the plot; the reason was to observe its influence on the growth of the tree in a monthly period. However, leaves and young branches are not removed.

C. Pollarding of all branches once a year, leaving the pollarded material on the ground.

A square is surrounded on to the planting of the "plot" treatment established by seedlings. The "pollarded" treatment has about 60% less materials per plant than pollarding of older trees. However, older trees of containers pollarding, the opposite of the plot trees with adjacent trees planted by large shingles is in a similar that no difference could be detected.

The "pollarded" plot had about 400 trees (3 x 10 trees) in each block consisted of three plots with 12 trees and measured 475 cm.

The total area of the experiment was about 3,080 m². Within each block the treatments were conducted using pool method.

The variables considered were the following: biomass from pollarding (kg), number of branches per tree, basal area of the crown (m²).

"Pollarding" trees twice a year is different from pollarding "pollarded" trees once a year, but the differences are not clear.
Diameter at breast height (dbh) of the trees (cm), total weight of the branches and amount of organic litter layers.

Polination and fruit setting

In September 1986, all trees were totally and continuously pollinated (covering all branches of the top of the trees). After pollination, one branch each in the four rings were marked for recording of diameter at breast height, weight and leaf litter. In September 1987, all trees were again pollinated after one year of the trees lost branches (twice normal rate) and two new rings were added. To investigate a possible change of pollination, twice new rings were pollinated in January, April, and September 1987 to assess fruit production. In December 1986, the lime-sized fruits were removed from the trees and weighed. To determine the number of seeds, the fruits were processed in the laboratory. The seeds were dried and weighed. The dry weight of the seeds was calculated and the number of seeds per fruit calculated. The differences between the years were significant (p < 0.05).

Alternatively, abscised of the fruits were collected, dried to constant weight, and counted in the laboratory. The differences between the years were significant (p < 0.05).

Before each pollination, the number of branches, the crown area, and the diameter at breast height were measured for all trees. The data obtained was related to the growth, with and without pollination, as presented in Figure 4.
Pollen borne sampling

Five representative quadrats of 50 steps were placed within each plot at
symmetrical intervals of one meter from the base of the tree. Collection and
evaluation of pollen were carried out each ten days. Each of the four
trees in a given area were placed as one of the four sections. A total of 80
steps were placed, 20 in the twelve month plot and 40 in the six-month
plot (Plates 1-2).

Results

Until September 1952, a series of measurements showed that there was no
significant difference between the measured pollination moments and the
annual pollination moment; however, there were no differences in biomass
production between the plots where the leaves were left on the ground and
those where the leaves were removed from the plot. Data from biomass
production for the coverages are presented in Table 1.

Table 1. Biomass production (dry weight) for leaves and branches of Fritillaria pumila
growth zone.

<table>
<thead>
<tr>
<th>Coverage</th>
<th>Leaves</th>
<th>Branches</th>
<th>Fruits, total biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pollinated</td>
<td>3.17</td>
<td>1.93</td>
<td>1.629</td>
</tr>
<tr>
<td>2. Pollinated</td>
<td>0.10</td>
<td>0.32</td>
<td>0.095</td>
</tr>
<tr>
<td>3. Unpollinated</td>
<td>0.10</td>
<td>0.32</td>
<td>0.095</td>
</tr>
<tr>
<td>4. Unpollinated</td>
<td>0.10</td>
<td>0.32</td>
<td>0.095</td>
</tr>
</tbody>
</table>

*Values with the same letter in the same column are statistically different (P < 0.05).

Annual biomass production, expressed in height, is highest in the
pollinated areas, leaves, and those taken once per year, and in the
pollinated areas, leaves, and those taken once per month, as shown in Table 2.

Values expressed with three different pollination frequencies with one,
two, and three pollinations per year (respectively every 3, 6, and 9 months),
and leaves, (0.5 years), and branches, (2 years), are presented in Table 3.
The highest percentage of the weight for the five branches was found in the
branches in all even months showed statistically the highest percentage.
Figure 1: Annual litter mass production (kg ha\(^{-1}\)) for leaves and branches of E. sapotifolia and E. guineensis in three treatments.

Figure 2: Percentages of leaves and branches of E. sapotifolia and E. guineensis at 0, 6, 12, and 18 months.

There was a significant difference in litter mass production between the two species. The highest litter mass production was observed in the E. sapotifolia treatment. The percentage of leaves and branches of E. sapotifolia in the litter mass was 65%, 78%, and 82%, while in E. guineensis, it was 52%, 60%, and 65%. The amount of nitrogen removed was very similar when leafed mass was used over one year. The litter mass of leaves removed was lower.

Phosphorus showed the lowest total amount among the five nutrients tested. No significant difference was found for phosphorus content from the ground between the two publishing species. The amount of caloric...
Table 2. Annual biomass production. The weight of fresh leaves was measured and the dry weights of the leaf material were determined. Data are means of three replicates (± standard error). *Significant at P < 0.05.

<table>
<thead>
<tr>
<th>Period</th>
<th>Leaf biomass</th>
<th>Trash biomass</th>
<th>Potential leaf biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premonsoon</td>
<td>151.5 ± 2.5</td>
<td>24.15 ± 1.21</td>
<td>156.5 ± 1.25</td>
</tr>
<tr>
<td>Monsoon</td>
<td>206.0 ± 3.0</td>
<td>34.23 ± 1.13</td>
<td>240.2 ± 3.15 *</td>
</tr>
<tr>
<td>Postmonsoon</td>
<td>155.5 ± 2.0</td>
<td>25.25 ± 1.25</td>
<td>180.7 ± 2.25</td>
</tr>
</tbody>
</table>

Data from 2015, not including
Data from 2016, use of mild pruning
Data from 2017, use of severe pruning

Table 3. Mean percentage (%) of pooled biomass of Cyrtodiaphora asparagi by pollination frequency in Capsicum annuum.

<table>
<thead>
<tr>
<th>Pollination Frequency</th>
<th>Leaf biomass</th>
<th>Trash biomass</th>
<th>Potential leaf biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 per week</td>
<td>155.5 ± 2.0</td>
<td>25.25 ± 1.25</td>
<td>180.7 ± 2.25</td>
</tr>
<tr>
<td>2 per week</td>
<td>149.5 ± 1.5</td>
<td>24.5 ± 1.25</td>
<td>174.0 ± 1.25</td>
</tr>
<tr>
<td>3 per week</td>
<td>141.5 ± 1.0</td>
<td>23.5 ± 1.0</td>
<td>165.0 ± 1.0</td>
</tr>
</tbody>
</table>

Pollination was highest with manual pollination due to the particularly high percentage of flowers in the lower part of the flower, which can be explained by the fact that the flowers in the lower part of the flower are more easily pollinated by the flowers in the upper part of the flower. Manual pollination showed similar trends to those observed in natural pollination.

The data in Tables 1 and 2 reveal that the highest percentage of biomass is achieved with manual pollination.
Table 1. Mean and standard error (in brackets) of included biomass of Echinochloa species, across the 3 years of study.

<table>
<thead>
<tr>
<th>Planting System</th>
<th>Br</th>
<th>Pr</th>
<th>Co</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latex</td>
<td>2.28</td>
<td>98.9</td>
<td>41.1</td>
<td>26.3</td>
<td>39.3</td>
<td>13.6</td>
</tr>
<tr>
<td>Bakery</td>
<td>2.78</td>
<td>107.2</td>
<td>55.1</td>
<td>29.4</td>
<td>47.5</td>
<td>18.7</td>
</tr>
<tr>
<td>Fish</td>
<td>3.03</td>
<td>113.8</td>
<td>60.4</td>
<td>33.6</td>
<td>50.2</td>
<td>19.8</td>
</tr>
<tr>
<td>Total</td>
<td>33.8</td>
<td>28.9</td>
<td>14.0</td>
<td>14.0</td>
<td>14.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Latex</td>
<td>0.16</td>
<td>121.3</td>
<td>52.5</td>
<td>29.8</td>
<td>29.8</td>
<td>12.9</td>
</tr>
<tr>
<td>Bakery</td>
<td>0.20</td>
<td>124.2</td>
<td>60.2</td>
<td>32.5</td>
<td>32.5</td>
<td>14.7</td>
</tr>
<tr>
<td>Fish</td>
<td>0.28</td>
<td>127.7</td>
<td>65.1</td>
<td>33.6</td>
<td>33.6</td>
<td>15.6</td>
</tr>
<tr>
<td>Total</td>
<td>11.7</td>
<td>221.6</td>
<td>104.6</td>
<td>60.6</td>
<td>60.6</td>
<td>28.3</td>
</tr>
<tr>
<td>Latex</td>
<td>0.12</td>
<td>116.3</td>
<td>58.4</td>
<td>30.8</td>
<td>30.8</td>
<td>12.5</td>
</tr>
<tr>
<td>Bakery</td>
<td>0.20</td>
<td>123.6</td>
<td>61.9</td>
<td>32.9</td>
<td>32.9</td>
<td>15.0</td>
</tr>
<tr>
<td>Fish</td>
<td>0.25</td>
<td>126.0</td>
<td>65.4</td>
<td>33.7</td>
<td>33.7</td>
<td>15.5</td>
</tr>
<tr>
<td>Total</td>
<td>8.20</td>
<td>172.4</td>
<td>112.0</td>
<td>60.0</td>
<td>60.0</td>
<td>58.7</td>
</tr>
</tbody>
</table>

1 Data from 30 June, one round pollination
2 Data from 30 June, two rounds pollination
3 Data from 30 June, one of two pollinations

Discussion

Comparison among two pollinated once, twice, and three a year.

Choosing the second harvest season for these pollinated treatments, once a year was the highest of the three regimes investigated. However, there were significant differences in the relationships between the two harvests. These differences between the harvests were more pronounced in the first train. The second harvest was approximately four months, while the first harvest was more mature. In contrast, the second harvest was more mature and the mean production of both harvests was more similar. This fact is significant, especially for landowners who might want to use the foliage mainly as a hedge plant material.
Table 6. Distribution of leaf malolactic competence and leaf area in 20% of plants per date, classified according to the presence or absence of a 0.5% concentration of oxalic acid. The data are mean values calculated from 10 measurements. Sheet 6.5

<table>
<thead>
<tr>
<th>Variety</th>
<th>1 week</th>
<th>2 weeks</th>
<th>3 weeks</th>
<th>4 weeks</th>
<th>5 weeks</th>
<th>6 weeks</th>
<th>7 weeks</th>
<th>8 weeks</th>
<th>9 weeks</th>
<th>10 weeks</th>
<th>11 weeks</th>
<th>12 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
<td>10.2</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Minimum</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
</tr>
<tr>
<td>Maximum</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
</tr>
</tbody>
</table>

The data are mean values calculated from 10 measurements.
Nutrient removal through polishing

The total amount of nitrogen removed is very similar for corn and winter
polishing treatments, but for those in a year to be known.

The amount of nitrogen removed was approximately 200 kg/ha in the
first two years and 250 kg/ha in the last one. This amount is estimated
inadequate for most crops if both the field beans and the polished
beans are left on the ground. For instance, Blicher (1983) reports that
crops such as sugar and corn, require nitrogen levels of 60-100
kg/ha to reach their maximum yields. However, if this nitrogen
be removed by winter beans, it can be estimated that little of the corn
would be restored. This seems to provide possibilities for only cropping,
which is in fact investigated by several ongoing projects at CATIE.

Polishing of beans and their effects on associated crops

The above observations suggest that a considerable supply of nutrients
is necessary with the previous crops, when these are successfully polished.
On the other hand, it is not easy to be said that one system of polishing is
to better than the other since this depends on the farmer's objective and what
products will be expected from the site or left on the ground. Usually the
micronutrient sources present the one that can be determined by the amount of
nitrogen fertilizer, as well as physical quality of the wood. In fact, naturally grown Eucalyptus
species are generally different from the usual species in terms of mechanical
strength and another evident quality such as hardiness is significantly
confirmed in the species to exploit or give new varieties after being
out back, thus, excellent future species may be expected as study cases
because they do not contain to flower much.

The present data are comparable to those reported by Abeyta et al. (1984),
Glover (1984), and Glover and Dre (1983), and it can be concluded that E.
palustris has a positive effect on forest yields. The present study can be
generalized. Like the basis of better yield, the species when generally
planted will show a better result than the control, when compared to open
growing trees without fertilizing. As to nitrogen fertilizer capacity, it is not yet clear how noticeable micro
forestry, but it can certainly be expected that the higher trees will improve the
silviculture because many species are dying and site is improved also
the addition of fertilized materials to the soil is likely to increase high levels of
timber yield even though no economic differences could be detected after 12
years. However, the present study is likely to change after a few more years. It is significant that 12 years
ago on the same side vines the study was carried out, similar quantities of
organic matter, forest recovery, as well as similar physical soil characteristics,
were already reported (Abeyta, 1983).

It cannot be explained how the benefits of fertilizer on E. paxalis will be
presented: recycling and adding reserves back to the soil, through effects
fertilizers are expected to improve the growth of the whole plant system (organic)
and hence quality of yields even late (Habib, 1983; Hanboto, 1972; Glover et al., 1983)
It remains however to be seen whether such knowledge will be essential
to measure forests and maintain well fertilized stocks to reduce
production. In fact it is also clear that all forests of Eucalyptus in the
basement of Eucalyptus, the forest before Eucalyptus paxalis, have been
several treatment with fertilizer, as well as in the Eucalyptus, Eucalyptus
paxalis. They are mainly found in the Central Valley, of Costa Rica, near forests of Eucalyptus paxalis
species have been fertilized elsewhere, as well as in La Venta, Costa Rica.
Additionally, these forests have been fertilized with other products, though in the
coffee area. They are already trusted by growers which can be
sustained by heavy utilization of fertilizers, even intense use of pesticides,
and shows that yields of coffee are as the situation of key yield factors to show where extra water is important. Even after fertilization, although a more regulated system of planting and harvest is necessary to ensure that the beans are properly matured in the coffee belt, the yields are still high. As a result, the coffee belt is a highly productive area even under unfavorable conditions. Many of the biscuits and chocolate that are produced in this region are high quality and are exported to other countries. The coffee belt is a major contributor to the national economy.

Conclusions and following questions:

The results derived from experimental plots, show that there are specific advantages among various populations, times, and doses. In addition, it is possible to achieve higher yields by improving the farming practices. These results indicate that the coffee belt is an area with great potential for further improvement through better management and increased investment. The following questions arise:

1. How can the results be applied to other regions and crops?
2. What are the long-term effects of these practices?
3. How can the benefits of these practices be sustained over time?
Moratorium should be invoked for a longer period, inasmuch as the value of E. penicillata might be as great as that of A. spaltleri. The species is a good foliage plant for fuel, and its foliage is of high quality for pulpwood. It is also a good rootstock for the production of ornamental trees. It is a valuable species for the production of pulpwood and woodchips. The species is also a good substitute for the production of ornamental trees.