The Abundance and pollinators’ impact on seed setting of Leucaena leucocephala in Wazo Hill restored Quarry, Tanzania

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ABSTRACT

Several studies have showed that, restoration has potential to increase the diversity of pollinators thus impacting on the seed setting of the plants. This study aimed at determining the abundance of Leucaena leucocephala and impact of high pollinators diversity on seed setting of Leucaena leucocephala in restored sites. The number of plants was counted in the quadrats for both restored and unrestored areas. The seeds for 130 pods collected, were counted with equal number of pods from restored and unrestored areas. The abundance of seeds in the two sites was not statistically different (P>0.05) while the higher vigor and number of seeds were observed in the restored area (p<0.05). Nutrients, sunlight and spacing were suggested to impact the vigor of the plants while pollinators’ differences in the two sites led to dissimilarity in the seed setting of the plants. From this study it is evident that, ecosystem restoration in mined areas has positive impact on biodiversity in general and Leucaena leucocephala in particular.

Key words: Abundance, Leucaena leucocephala, Pollinators, Seed setting, Wazo hill, Restored quarry.

INTRODUCTION

Ecological restoration in Wazo hill quarry is part of the activities going on under the Tanzania Portland Cement Company (TPCC) [1]. Leucaena leucocephala is fast-growing mimosoid tree commonly known as white leadtree, jumbay, and white popinac [2], that is among the plant species which are involved in the restoration program. L. leucocephala is an angiosperm, thornless long-lived shrub or tree in the order of fabales and family fabaceae. It may grow to the height of 7-18 m with bipinnated leaves of 6-8 pairs of pinnae bearing 11-23 pairs of leaflets with 8-16 mm long. The inflorescence composed of a cream coloured globular shape that produces a cluster of flat brown pods that measure 13-18 mm long and having 15-30 seeds. [3] described three morphological types of L leucocephala that are small, bushy Hawaiian type under five metres; tall Peruvian type with several stems to 15 meters and Hawaiian giant type with a trunk and a big size up to 20 metres.

A study done in Wazo hill showed that, Leucaena leucocephala has a positive potential in alleviating poverty of the local communities around the restored quarries through its use as fodder for meat and milk production as the plant is known for its high protein value [4]. The potential of Leucaena leucocephala for human use is well known worldwide. [2] has reported that, the leafs of Leucaena leucocephala have high nutrition values to ruminant animals, necklaces production from seeds and the young leaves and seeds used as vegetables. However the influence...
of restoration process on the impacts of pollinators to seed setting of this valuable plant species was unknown in Wazo hill quarry.

The diversity and abundance of potential Pollinators like butterflies were observed to be higher in the restored area than either unmined or unrestored area [5-6]. Several studies have showed that, the pollination efficiency have impacts on the seed setting to the plants thus impacting the reproduction success of the plants [7-8]. It is anticipated that, the restored area with high diversity and abundance of pollinators will have high abundance, fruit setting per pods and vigor of Leucaena leucocephala than the unrestored. In spite of this idea, still nothing was proven in Wazo hill, thus facilitated this study to be perpetuated.

It is our expectation that, the finding from this study will provide a clue for monitoring the pollinators in the Wazo hill quarry. Also, it will help the TPCC factory administration to incorporate pollinators in the integrated ecosystem management. The ecological knowledge in this area will be added. Pupils, local communities and university students will learn the importance of ecological restoration for pollinators to plants that are vital to humankind. This will help the company to gain public support for conservation effort in the Wazo restored quarry site. Also poverty alleviation of the local communities depending on L. leucocephala crops through increased production associated with pollinators activities.

The main objective of the study was to determine the influence of the ecological restoration on the abundance of the L. leucocephala and impacts of pollinators on the seed setting. The following were the specific objectives; to determine and compare the seed set per pods between the restored and unrestored sites; to determine the abundance of L. leucocephala in the restored and unrestored sites.

MATERIALS AND METHODS

Study area
The study took place at Wazo hill quarry area, Dar-es-Salaam, Tanzania. Wazo Hill is located between latitude 6°34’ South and longitudes 39°23’ and 39°25’ East at Tegeta area that is located at a distance of 25Km from the Dar es Salaam city centre. The rich rock material extending for about 2.5 km parallel to Dar es Salaam-Bagamoyo road, has 15M thick coral limestone bed reserve estimated at 20Mt [1]. The area has daily temperatures averaging at 27°Celsius, where the highest air temperature goes up to 31°Celsius [5-6].

The rainfall is high ranging from 1,000 to 1,900 mm per year. The rainfall pattern is bimodal where a period of short rains occurs between October and December and a period of long rains is between March and May. June, July and August are dry season in this area. The vegetation dominating the area is Eastern African Coastal vegetation.

Abundance of Leucaena leucocephala
The abundance of Leucaena leucocephala was sampled in both restored and unrestored sites. In each site two transects of 50m apart were set for sampling the L. leucocephala. In each transect 5 quadrats of 5mx5m each were set at interval of 50m apart. In each quadrat, the amount of L. leucocephala was counted and estimated their average height to determine their vigor. Mann-Whitney U test statistic was used to determine the difference in abundance of the L. leucocephala between the two sites at α=0.05.

Seed setting per pod.
Seed setting is among the output of pollination success. The seed setting experiment was contacted in both restored site and unrestored sites. Sixty five (65) pods were randomly picked in each study sites. Each pods was opened and seeds on it were counted. Mann-Whitney U test statistic was used to determine the difference in seed setting between the two sites at α=0.05.

RESULTS

Abundance of Leucaena leucocephala
A total of 20 quadrats (equivalent to 5000m²) were surveyed in the four transects with equal number in restored and unrestored areas. In both sites the total abundance of L. leucocephala was 219 (Mean=10.950±3.325, S.D= 4.870). The range was 64.000 with minimum of 0, kurtosis of 8.511 and Skewness of 2.715. The unrestored area (Mean=16.700± 6.204, S.D=19.619, Range=2.000, Min=0.000) had higher abundance of L. leucocephala than restores site.
(Mean=5.200±0.917, S.D=2.898, Range=10.000, min=1.000). However the difference saw statistical insignificant (Mann-Whitney U test statistic = 36.500, P>0.05). In comparison to plant vigor in terms of height, the restored site showed significant higher than the unrestored (Mann-Whitney U test statistic = 86.000, P<0.05), illustrated in Figure 1. There was slightly correlation between the abundance and average height. The relationship was not significant negatively correlated (y=-0.0058x+4.2384, R²=0.0013, P>0.05).

Figure 1: The average height of *L. leucocephala* in unrestored and restored sites in Wazo hill quarry.

**Seed setting per pod.**

A total of 130 pods of *L. leucocephala* were sampled in the study sites, this yielded a total amount of 2454 seeds. Generally, there was significant higher number of seeds per pod in the restored area than unrestored area (Mann-Whitney U test statistic = 2728.000, P<0.05) (Also See Table 1).

<table>
<thead>
<tr>
<th>Statistic measure</th>
<th>Unrestored area</th>
<th>Restored site</th>
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</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>4.000</td>
<td>11.000</td>
</tr>
<tr>
<td>Maximum</td>
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</tr>
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</tr>
<tr>
<td>Sum</td>
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<td>1299.000</td>
</tr>
<tr>
<td>Median</td>
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<td>21.000</td>
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<tr>
<td>Mean</td>
<td>17.769</td>
<td>19.985</td>
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<td>18.751</td>
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</tr>
<tr>
<td>95% CI Lower</td>
<td>16.787</td>
<td>18.859</td>
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<td>Std. Error</td>
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<tr>
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<tr>
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<tr>
<td>Skewness (G1)</td>
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<td>SE Skewness</td>
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<tr>
<td>Kurtosis (G2)</td>
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<td>-0.658</td>
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<tr>
<td>SE Kurtosis</td>
<td>0.586</td>
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</tbody>
</table>

[8]

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DISCUSSION

Generally there was variation between the restored area and unrestored area in terms of abundance and seed set of the *L. leucocephala*. The restored area showed positive respond in terms of abundance and seed set per pod. This agrees with the study done by [5]; [9] in this site which showed that restoration has positive impacts on the welfare of biodiversity including the *L. leucocephala*. Through this study it was observed that, the restored area had higher biodiversity health than other sites, like for example unrestored sites.

**Abundance of Leucaena leucocephala**

The abundance in the two sites were not observed to be significant different. This can be explained by the fact that, some quadrats in the same transect of unrestored site were observed to have few or none *L. leucocephala* while other quadrats had crusted *L. leucocephala* plants. This was different with those observed in the restored site where, the plants were observed to be evenly distributed. For instance the quadrat with highest abundance in the unrestored site was found to have 64 plants (at GPS co-ordinates of 0517783, 9294522) while the lowest had 0 plants (at GPS co-ordinate of 0516442, 9264690). In the restored area the quadrat with highest abundance was observed to have 11 plants (at GPS co-ordinate of 0 518035, 9264466) while the lowest had 1 plant (at GPS co-ordinate of 517932, 926455). The high clustering in plants in the unrestored area lead to elevated competition for resources to the plants. This lead to reduced vigor in terms of their height. Other studies have showed that, the resources like light, and nutrients have high impact on the survival and vigor of *L. leucocephala*. For instance [10] revealed that, nitrogen content in the soil has implication in the growth rate and performance of the plant while salt stress lead to negative performance.

**Seed setting per pod.**

In comparison between the restored and unrestored areas in terms of seed setting, significantly higher number of seeds were observed in the restored area. The impact of pollinators on the seed setting are essential to explain this. The previous study showed that, the diversity of pollinators such as butterflies were found to be in the restored area [5]. The highest diversity of pollinators in this area can elucidate that, visitation and flower probing by the pollinators is expected to be soaring in this site. Other studies have proven this phenomenon. For example, Insects (open pollination) were discovered to increase the number of seeds per pod, weight of pods, seedling vigor, weight of seeds, germination success and oil contents of *Sesamum indicum* in Egypt [11]. However other factors like nutrients, sunlight, pest and diseases need to be considered too.

CONCLUSION

From this study it is evident that, the abundance of *L. leucocephala* is not affected by the restoration program but their vigor is highly impacted due to proper management like weed control, spacing and nutrient supply in the restored area. However seed setting were highly impacted by the restoration programme in Wazo hill. The high impacts of the restoration in Wazo hill was due to the attracted pollinators like butterflies, bees and beetles which facilitated the reproduction success of the *L. leucocephala* through high seed production. The ecosystem restoration in mined area has positive impact not only on the *L. leucocephala* but also biodiversity at large.

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REFERENCES


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