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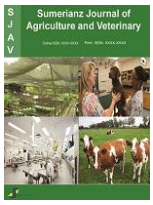

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The Susceptibility of Eucalyptus Species Seedlings to Red Gum Lerp Psyllid (*Glycapsis Brimblecombei*) In Lilongwe Malawi

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Abstract

Red Gum Lerp Psyllid (RGLP), *Glycaspis brimblecombei* Moore (Hemiptera: Pysllidae) is an insect pest that attacks various *Eucalyptus* species by causing leaf discolouration, severe leaf drops and twig dieback. Extensive attacks weaken the tree and make it prone to other secondary pests. There is a continued practice of planting different *Eucalyptus* species without considering whether they are susceptible or not to RGLP attacks. This might hinder the success of afforestation and reforestation programmes. In this study, seven months old, *E. camadulensis*, *E. maidenni*, *E. tereticornis* and *E. grandis* species tree seedlings at Bunda Forest Reserve tree nursery in Lilongwe, Malawi were tested to determine their susceptibility to RGLP attacks, which part of the leaf is mostly attacked by RGLP and to determine the survival rate of the susceptible *Eucalyptus* species. The seedlings were exposed to a highly infested *Eucalyptus* species trees for one month and twenty days. Data was being collected at a ten-day interval. The results indicate that there were significant differences (P<0.05) on Damage Indices (DI) among the *Eucalyptus* species. *E. camadulensis* and *E. tereticornis* were severely susceptible to RGLP with DI of 2.9 and 2.7, respectively. On the other hand, *E. grandis* and *E. maidenni* were medium and resistant to RGLP with DI of 1.2 and 0, respectively. There were more RGLP lerps on abaxial part of the leaf surface than on its adaxial part of leaf surface. *E. maidenni* had the highest survival rate (100%) followed by *E. tereticornis* (90.5%). Both *E. camadulensis* and *E. grandis* had the lowest survival rate (85.7%). Raising of *E. maidenni* tree seedlings which is resistant to RGLP attacks may promote the successful afforestation and reforestation programmes in Lilongwe, Malawi and areas with similar environmental conditions with Lilongwe.

Keywords: *Eucalyptus species*; Red gum L.P; Damage index; Survival rate.

1. Introduction

Red Gum Lerp Psyllid (RGLP), *Glycaspis brimblecombei* Moore (Hemiptera: Pysllidae) is an insect pest that attacks various *Eucalyptus* species by causing leaf discolouration, severe leaf drops and twig dieback. Extensive attacks weaken the tree and make it prone to other secondary pests [1]. Immature RGLP (nymphs) resembles aphids; the body colour is yellowish orange, with dark-brown coloration on the wing pads, legs, antennae, last abdominal segments, and in blotches on the dorsal areas of the head and thorax. The wing pads and other parts of the body have bright white spots associated with setal positions. The RGLP nymph constructs a white conical cover of crystallized honeydew, called a lerp, and feeds concealed under this shelter [2]. But a RGLP is yellow or light green in colour with contrasting dark eyes, and occasional dark brown markings. The genal cones, a common morphological feature of most psyllids, consist of a pair of cone-shaped extensions of the frons and may extend anteriorly or downward depending on the head orientation of a given species. In RGLP, the genal cones are extremely long and well developed, being as long as or longer than the head itself [3]. Adults are approximately 4-5 mm in length from the head to the wing tips. A female RGLP is bigger in size than the male one.

Lerp insects usually live in colonies of mixed stages. Each female lay between 45 and 700 eggs. Eggs are laid randomly on the leaves or in clusters of 50-75 eggs, usually at an angle or perpendicular to the plant surface. They are spindle-shaped, yellow or cream coloured, and are slightly less than 1 mm in length [3]. Eggs hatch and the young nymphs or "crawlers" move about the host plant searching for a place to settle; usually settling within 48 hours of hatching. Once settled they insert their stylets (mouthparts) into the leaf and begin feeding, and excreting honeydew which hardens on contact with air to form a lerp. Nymphs pass through four stages or moults before becoming winged adults. At every moult the insect withdraws its stylets from the leaf and selects a new feeding site. The new site is usually within the existing lerp but occasionally the insect moves to a new site and constructs a new lerp [3]. Nymph size varies depending on the instar; last instar is approximately 1.5-2.0 mm in length. Lerps are 1-4 mm in diameter depending on the stage of the nymph, and are usually whitish in appearance, but may take on a grey

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or black colouration with age or if sooty mould begins to grow on the lerp. The insect pest undergoes incomplete metamorphosis.

There is continued practice of planting *Eucalyptus* species without considering whether a particular *Eucalyptus* species is susceptible to a particular pest. There is well defined information on a number of insect pests attacking eucalypts such as defoliators, gall forming insects, stem borers and sap suckers [4, 5]. However, RGLP being a newly introduced insect pest in Malawi, there is little information available pertaining to hosts, impact and control. This might be one of the hindrances to a successful afforestation and reforestation programmes in Malawi. *Eucalyptus* species are preferred due to their fast-growing characteristics as well as their adaptability to a wide range of environmental and site conditions. The practice of planting *Eucalyptus* species which are susceptible to the RGLP will continue if such studies are not carried out. Therefore, this research was conducted to assess the susceptibility of different *Eucalyptus* species to the RGLP. Specific objectives of the study were to: (i) determine the insect pest severity of different *Eucalyptus* species to RGLP; (ii) determine which part of the leaf (Adaxial or abaxial) is preferred by RGLP; and (iii) assess the survival rate of the infested *Eucalyptus* species. The findings from this research might be used in developing the policy and practice on which *Eucalyptus* species to be planted to avoid losses due to RGLP attacks.

2. Materials and Methods

2.1. Study Site

The study was carried out in Bunda Forest Reserve in Lilongwe, Malawi. The reserve was gazetted in 1948 and covers an area of 426 ha [6]. It is located in Central Region of Malawi and lies on latitude 14°09'S and longitude 33°47'E. The altitude of the reserve is approximate 1338m above sea level. It is in Zone D of Silvicultural Zones of Malawi whose temperature range is 19 ^{o}C - 21 ^{o}C. Mean annual rainfall ranges from 840-960mm. The soils are ferruginous and lithosols [7]. It comprises both indigenous and exotic tree species. Amongst the exotic tree species is *Eucalyptus*.

2.2. Sampling Design

Two months old *Eucalyptus* seedlings were collected from Malawi College of Forestry and Wildlife Nursery in Dedza in May 2018. The seedlings were kept at Bunda Forest Reserve Nursery for four months. The four *Eucalyptus* species were: *E. camadulensis*, *E. maidenni, E. grandis, and E. tereticornis.* For each species, seedlings were laid out in a randomized complete block design with three replications and twenty-one (21) seedlings per replication. At the age of seven months, the seedlings were exposed to RGLP infested *Eucalyptus* trees. After 10 days of exposure, each seedling was assessed to record presence of lerps on the leaves. This was done for five times in a 10-day interval.

2.3. Data Collection and Sources

Observation method was used as one way of collecting the primary data from the established plot. The number of lerps on each tree species was observed, counted and recorded. The secondary information was retrieved from the journals, books and internet.

2.4. Data Analysis

The number of lerped leaves was recorded as a percentage of the total leaves on the plant. Lerp severity was scored for each seedling as follows; 1= No leaves with lerps; 2=1-25% of leaves with lerps; 3= 26-50% of leaves with lerps; 4=51-75% of leaves with lerps and 5=more than 75% of leaves with lerps. Damage Index (DI) was calculated as the product of the incidence (proportion of plants infested) and mean severity (percentage infestation/100). Based on the DI, damage severity levels were identified as none for DI=zero, Low for DI=0.1-1, Medium for DI=1.1-2.0, Severe for DI= 2.1-3.0, and very severe for DI>3. Data obtained on DI was tested for normality and homogeneity with Kolmogorov-Smirnov D and normal probability plot tests using R Stat (R-3.4.3). After the two criteria were met the data were subjected to analysis of variance (ANOVA) using the same R Stat (R-3.4.3) software with eucalyptus species as fixed factor. Differences between treatments means were separated using Fischer's least significant difference (LSD) at the 0.05 level. Graphs were plotted using Microsoft Excel 16.

3. Results and Discussion

3.1. Insect Pest Severity of Different Eucalyptus Species to RGLP Attacks

Summary of the results on insect pest severity on different Eucalyptus species to RGLP attacks are presented in Table 1. The results indicate that there were significant differences (P<0.05) on Damage Indices (DI) among the *Eucalyptus* species. *E. camadulensis* and *E. tereticornis* were severely susceptible to RGLP with DI of 2.9 and 2.7, respectively. On the other hand, *E. grandis* and *E. maidenni* were medium and resistant to RGLP with DI of 1.2 and 0, respectively.

The present findings are in agreement to the research findings by Huerta, *et al.* [1] in Argentina that *E. camadulensis* and *E. tereticornis* are severely attacked by the Red Gum Lerp Psyllid. However, this is in contrary to Petro [5] who reported *E. camadulensis* to be very severe (DI>3) than *E. tereticornis*. On the other hand, Huerta, *et al.* [1] and Petro [5] reported that among the range of *Eucalyptus* species that are preferably colonized by the Red Gum Lerp Psyllid, *E. grandis* and *E. maidenni* are medium and resistant to RGLP respectively. The difference in susceptibility of these *Eucalyptus* species is genetically articulated to a large extent [8]. He reported that the variation

in susceptibility of these *Eucalyptus* species is due to difference in contents of essential oils in these *Eucalyptus* species. For example, in *E. camadulensis* and *E. tereticornis* there is a higher concentration of 1, 8-Cineole, 4-Terpineol and Cryptone unlike in *E. grandis* and *E. maidenni*. *E. maidenni* in addition to the lowest concentration of the essential oils, it has also the epicutical waxy substances on its leaves which discourages attractiveness and oviposition by RGLP [8].

Table-1. RGLP Damage Index for different Eucalyptus species

Species name	Total sample	Damage Index (DI)	Damage Severity Scale
Eucalyptus camadulensis	21	2.9[a]	Severe
Eucalyptus tereticornis	21	2.7[a]	Severe
Eucalyptus grandis	21	1.2[b]	Medium
Eucalyptus maidenni	21	0.0[c]	Resistant

Note: [a,b,c]DI with different superscript within a column significantly differ (P<0.05)

3.2. Part of the Leaf liked by RGLP

The study revealed that Red Gum Lerp Psyllid prefers constructing the lerps on both sides of the leaf (abaxial and adaxial) but more on the abaxial part of the leaf (Figure's 1 2 3). The findings are in agreement to what Strong, *et al.* [9] founded. In his research, he indicated that low-mobility herbivorous insects would avert the adverse environmental conditions by feeding on the abaxial leaf surface where the risks of being removed by winds and rainfall are minimized. Contrary, Oliveira, *et al.* [10] reported that Red Gum Lerp Psyllid constructs its lerps more on adaxial leaf surface. The contradictions on the most liked part by the RGLP may be attributed to the foliar dimorphism of the juvenile *Eucalyptus* species which were under the study.

Figure-1. Part of the leaf liked by RGLP

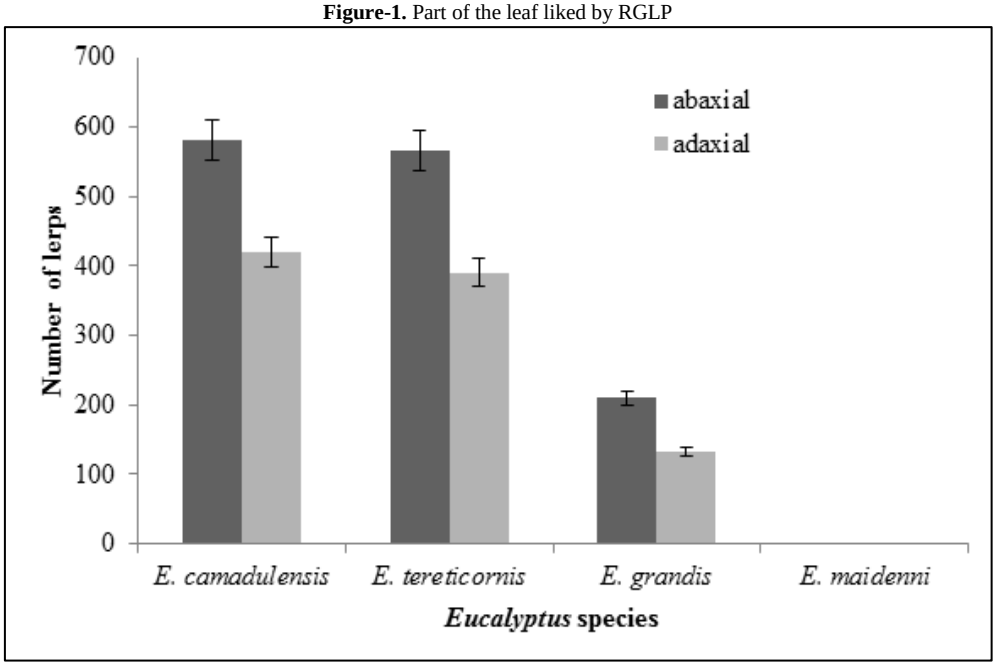

Figure-2. Lerps on abaxial leaf surface

Figure-3. Lerps on adaxial leaf surface

3.3. Survival Rate of the Infested Seedlings to RGLP

Results on the survival rate of the infested seedlings to RGLP are presented in Table 2. The results revealed that *E. maidenni* had the highest survival rate (100%) followed by *E. tereticornis* (90.5%). Both *E. camadulensis* and *E. grandis* had the lowest survival rate (85.7%). revealed a 100-percentage survival rate on *E. maidenni* species. The highest survival rate on *E. maidenni* was attributed to its resistance to Red Gum Lerp Psyllid attacks. E. *maidenni* had DI=0 and had no RGLP lerps on its leaf surfaces. *E. tereticornis, E. camadulensis and E. grandis* had the Red Gum Lerp Psyllids lerps on their leaves. The presence of RGLP lerps on the surfaces of leaves was affecting the photosynthesis process as these lerps shield the penetration of sun light energy. As the RGLP lerps shield the leaves' surfaces and suck nutrients from them, leaves senescence followed by the death of the entire tree species [11-14]. A highest survival rate of these findings is in agreement with Huerta, *et al.* [1] who reported that the impact of these Red Gum Lerp Psyllids on growth to survival of *Eucalyptus* species infested requires a longer duration study from young tree species (Seedlings) to mature tree species.

This study is based on one ecological zone, one season on the nursery and four *Eucalyptus* species. There is a need for extensive and long-term ecological studies to further improve knowledge of *G. brimblecombei* infestation and facilitate its control in the country and other tropical countries. Based on findings from this study and other *G. brimblecombei* studies, the following areas of research are recommended;

- Screening of a wider range of *Eucalyptus* species for tolerance and even resistance to RGLP.
- A study on the mechanisms governing resistance of *Eucalyptus* species to RGLP and therefore be able to better predict susceptibility of new genotypes or current genotypes planted in new areas.
- Seasonal variability of RGLP across the years in the country to understand how the pest responds to changes in climatic factors.
- Introduction and monitoring of the biological control agent, *Psyllaephagus bliteus* Riek (Hymenoptera: Encyrtidae), in highly infested areas.

Table-2. Survival rate of the infested seedlings to RGLP attacks

Species	Raised seedlings	Survived seedlings	Survival rate (S/R) %
E. camadulensis	21	18	85.7
E. tereticornis	21	19	90.5
E. grandis	21	18	85.7
E. maidenni	21	21	100

4. Conclusion

The study revealed that *E. camadulensis* and *E. tereticornis* were more susceptible to RGLP attacks. *E. grandis* was medium susceptible and *E. maidenni* was resistant to RGLP attacks. The difference in susceptibility may be due to differences in concentration of essential oils in these *Eucalyptus* species. *E. camadulensis* and *E. tereticornis* have the highest concentration of essential oils like Cryptone, 1, 8-Cineole and 4-Terpinol than in *E. grandis*. *E. maidenni*. The study further revealed that RGLP constructs its lerps on abaxial part of the leaf surface than on its adaxial leaf surface. This may be attributed to the fact that these low-mobility insect pests prefer the construction of lerps on the abaxial part of the leaf for protection to heavy winds and rainfall. *E. maidenni* had the highest survival rate followed by *E. tereticornis*. Both *E. camadulensis* and *E. grandis* had the lowest survival rate. Raising of *E. maidenni* tree seedlings which is resistant to RGLP attacks may promote the successful afforestation and reforestation programmes in Lilongwe, Malawi and areas with similar environmental conditions with Lilongwe.

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