

Final Evaluation Report

Your Details	
Full Name	Mecklina Michael Mbundi
Project Title	Effect of <i>Gutenbergia cordifolia</i> management on insect's diversity and flower visitation in Mwiba Wildlife Ranch
Application ID	30390-1
Grant Amount	£5995
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1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To determine the effect of <i>D. uncinatum</i> crude leaves extract (DUL) and chemical herbicide (glyphosate; GLY) against <i>G. cordifolia</i> on number of insect visitors after treatments				We observed that the number of insects visiting flowers in plots treated with GLY were highly reduced. The GLY effects on floral resources foraged by insects could have indirectly affected insect visitor survival rates and reduced their number. We learned that DUL not only manages to suppress an invasive, <i>G. cordifolia</i> , but also increases the number of insect visitors, and can be used in protected areas, where chemical herbicides are not recommended
To determine the effect of (DUL) and (GLY) against <i>G. cordifolia</i> on number of flowers visited				Our result confirms that glyphosate used as a non-selective synthetic herbicide negatively affects plant growth and causes rather non-specific plant death (Zhang, 2020). The low plant diversity due to chemicals leads to floral resource reduction (Muratet & Fontaine, 2015; Aniko <i>et al.</i> , 2017), and thereby reduced plant-derived food resources (i.e., nectar and pollen), which usually attract insects to flowers (Siregar <i>et al.</i> , 2016). While on the other hand, we found DUL treatment had no negative impact on the native flowering plant resources, which permitted more visitation of insects on DUL treated flowers.
To determine the effect of (DUL) and (GLY) against <i>G. cordifolia</i> on insect diversity and richness after treatments.				Contrary to our expectations, we did not observe any significant difference in insect diversity and richness across DUL, and GLY plots, in spite of variation in flower abundance and diversity. However, a small increase of insect diversity and species richness after treatment

			with DUL suggests that floral resources and, thus, pollinator networks, might have been at least improved through DUL treatment (Siregar <i>et al.</i> , 2016). We found that our bio-herbicide did not disturb non-targeted flower abundance and diversity, thereby guaranteeing the availability of resources that are critical for supporting diverse insect visitors (Hegland & Boeke, 2006). It is anticipated that insect richness and diversity will be higher in habitat with abundant floral resources (Blaauw & Isaacs, 2014).
To determine the effect of (DUL) and (GLY) against <i>G. cordifolia</i> on bee diversity and richness after treatments.			Our results indicated that bee diversity and richness were high in DUL plots, highlighting that DUL had no negative impact on efficient insect visitors, thus ensuring pollination and fertilisation of both crops and wild flowering plants. Alteration of plant availability by GLY could have negatively affected the bees and reduced their diversity and richness (Brito <i>et al.</i> , 2018).
To determine the effect of (DUL) and (GLY) against <i>G. cordifolia</i> on flower diversity and abundance after treatments.			We found that DUL treatment increased flower abundance and diversity, which has been shown to directly determine pollinator communities (Tonietto & Larkin, 2018). Our study provides an essential information on the negative impact of GLY towards flowering plants and insects in eastern African savanna systems as, the GLY treatment reduced flower abundance and diversity.
To examine the effect of (DUL) and (GLY) on soil chemical properties.			We partially reached this objective as we did not find significant effect of DUL and GLY treatment on any of our soil chemical properties. However, our results showed that mean pH value was slightly lower in GLY compared to CON and DUL which indicates that application of DUL to the ecosystem did not affect soil acidity while the application of glyphosate to the ecosystem slightly

			affected the soil by increasing small soil acidity, this is supported by other studies which have shown glyphosate increased soil acidity in farmland (Nigussie <i>et al.</i> , 2019).
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2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

- a) The changes in annual season had an influence on availability and growth of invasive *Gutenbergia cordifolia*. We delayed the start of the experiment and data collection from January to the end of March 2020 waiting for *Gutenbergia cordifolia* to bloom.
- b) Some of the research activities were delayed during the pandemic COVID -19 time in 2020, particular the fieldwork activities, which was supposed to take place at Mwiba wildlife ranch, the activities were involving the direct interaction with local community, Mwiba staff and research assistants. Most of these activities were difficult to conduct during the COVID-19 pandemic, therefore, we had to wait for sometimes before going back again to collect data in the field.

3. Briefly describe the three most important outcomes of your project.

- We claim that using 100% concentration level of *Desmodium uncinatum* crude leaves extract (DUL) as a management option against the invasive plant *G. cordifolia* is the best approach as it did not negatively affect insect flower visitors, flowers and soil chemical properties in contrast to GLY. Results showed that applied plant extracts had potential in attracting more insect visitors, we therefore, acclaim natural DUL herbicide as a highly preferred alternative to GLY for controlling *G. cordifolia* in eastern African savanna systems, and particularly inside of protected areas, where chemical herbicides are not recommended.
- We managed to share our findings during Rufford Conference presentations in Nairobi, Kenya December 2020, where participants from different East African countries participated in the conference.
- We highlighted species-specific effects of invasive *G. cordifolia* management by DUL and GLY on insect visitor communities (bees) in invaded sites of Mwiba wildlife ranch, for notifying the continuing management programmes on prioritising DUL management for current and future control and eradication of other invasive in Tanzania protected areas.

4. Briefly describe the involvement of local communities and how they have benefited from the project.

We managed to involve the local community around Mwiba wildlife ranch (the local villagers together with the primary pupils and secondary students) by raising their awareness on invasive plants, the management approaches and effect of management on insect visitors. We provided them with t-shirts with Rufford logo, exercise books and pens, and brochures.

5. Are there any plans to continue this work?

Based on our findings from the current study we plan to continue with this work, especially on the local awareness issue as during the interaction with the community surrounding our protected areas, we found that they lacked enough information on invasive plants, management and the effect of management on biodiversity. We think that intensive training and assessment on their perception towards invasive plant management is essential in preparing the best management approaches of invasive plants that has no adverse impact on our environment.

6. How do you plan to share the results of your work with others?

Our findings have been shared through seminars, conferences and meetings. We had an interesting opportunity to give the feedback of our work to Mwiba wildlife ranch staff by sharing with them the findings of our study. We have submitted a manuscript to the Journal for Nature Conservation entitled "Comparison of the effects of a broad-spectrum herbicide and a bio-herbicide on insect flower visitation in the Serengeti ecosystem, Tanzania". We also plan to attend further international conferences in the near future for the purpose of sharing our interesting findings, including the 13th TAWIRI Conferences in December 2021 which will involve more than 200 participants from than 30 countries around the globe.

7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?

We conducted this project for more than 18 months instead of the planned 12 months. Some activities were pushed forward because of season changes which affected the availability of the invasive *Gutenbergia cordifolia* and some activities were delayed due to outbreak of the pandemic disease the COVID-19 which interfered with our work. Therefore, due to the unforeseen events mentioned above, there were changes in the timetable.

8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Food costed 40£, water 40£ and refreshments 40£ per month for 8 months in the field	900	960	+60	we budgeted less amount than the actual amount.
2 Sprayer pumps each costed 20£ and 4 pair of hand gloves each will cost 5£	60	60		same amount budgeted was used.

10 pitfalls cups for the collection of ground dwelling insects each costed 2£	20	20		same amount budgeted was used.
6 Sweep nets for catching insects each costed 5£	30	30		same amount budgeted was used.
Internet cost 50£	50	50		same amount budgeted was used.
Stationery costs include 50£ printing, 50£ photocopying and binding of 50£	100	150	+50	We added £50 to the budgeted amount.
15 Field notebooks each cost 2£, 5 pencils box @ 4£ and data sheets cost of 20£	35	70	+35	We added £35 to the budgeted amount.
One laptop for statistical analysis costed 500£	300	500	+200	We added £200 to the budgeted amount.
Field guidebook for insects' identification at the cost of 30£	30	30		same amount budgeted was used.
Publications of research results will cost 300£	300	300		same amount budgeted was used.
First aid kit 2 @ 30£	60	60		same amount budgeted was used.
1 ranger for protection against wild dangers during data collection in the field was paid 5£ per diem for 200 days	1000	1000		same amount budgeted was used.
1 Field research assistant received 50£ per month stayed for 6 months	300	300		same amount budgeted was used.
Supervisory fee was 150£ for transport, accommodation and food expenses	150	150		same amount budgeted was used.
Researcher's accommodation cost was 30£ per month for 8 months	200	240	+40	We added £40 to the budgeted amount.
20 Pan traps bowls charged 40£	40	40		same amount budgeted was used.
Desmodium seeds. 10 bags each was charged with 5£	50	50		same amount budgeted was used.
Transport cost (local and ground costed 200£)	200	200		same amount budgeted was used.
Soil sample analysis costed 500£	500	500		same amount budgeted was used.
Local community, secondary students and relevant stakeholders training materials for about 50 participants; 50 notebooks @1£, 10 pen boxes @20£, 5marker pen boxes @10£,	400	500	+100	We added £100 to the budgeted amount.

10 flipcharts @5£, training hall will cost 150				
2 pairs of fields boot each cost 10£	20	20		same amount budgeted was used.
Two binocular lenses for viewing insects flower visitation at 250£	250	250		same amount budgeted was used.
One Digital camera cost 300£	300	300		same amount budgeted was used.
2 GPS was charged 700£	700	700		same amount budgeted was used.
Total	5995	6480	+485	for successful completion of the study, we added extra 485£ from AfDB our co-funding.

9. Looking ahead, what do you feel are the important next steps?

In this study we did not collect information on flower density during our field data collection campaign. Also, a study by (Tommasi *et al.*, 2021) suggests that the ratio between flower abundance and plant cover is calculated as a measure of flower density. In our current study, we did not collect such information on plant cover data and, therefore, we could not measure flower density. Since, this is an ongoing research project, and we are using the same study plots to collect data. Therefore, for our future projects we will collect data on flower density per plot and using them to analyse pollinator-visitation rates.

Another next step is to conduct further community outreach programme on invasive plants and management effect on biodiversity to more villages surrounding Mwiba area as we only covered one village which is very close to our study area. This will increase awareness and build capacity on biodiversity protection to more people.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

Yes, all of our posters, fliers, brochures, posters, presentations, and t-shirts had a Rufford logo as it increased the publicly of the foundation. We have also acknowledged the financial support of Rufford Foundation in our submitted manuscript for publication.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

Prof. Anna Treydte: my immediate supervisor monitored the progress of each stage of the research.

Dr. Issakwisa Ngondya: attended field activities and co-supervised the whole project.

Mark Ghau: checked all field activities and co-supervised the whole project.

Majaliwa Masolele: assisted in data analysis.

Dr. Alainy Paul: assisted in insect identifications.

Boniphace Paul: supported the project as a field research assistant.

Magdalena Tarimo: supported the project as a field research assistant.

Prof. Minnick Tamera: assisted in designing the methodology for data collection.

Mecklina Michael: Project leader who conducted all the activities including data collection, data analysis, presentations, manuscript drafting and submission to the journal, results disseminating and outreach activities.

12. Any other comments?

First and foremost, I must acknowledge the almighty God for giving me the strength and good health to finish this research work. On behalf of my team, I want to express our sincere gratitude to The Rufford Foundation for supporting our project financially. Through Rufford fund we were able to accomplish our project successfully, reach the community and Mwiba staff on the issue of managing invasive plant *Gutenbergia cordifolia* and the effect of management on insect flower visitation. Lastly, we have achieved a lot through this work especially in improving our career in nature conservation.