Scientific Research Publishing

Open Journal of Ecology, 2023, 13, 597-605
https://www.scirp.org/journal/oje
ISSN Online: 2162-1993
ISSN Print: 2162-1985

Shea Parklands Pollination in Burkina Faso, Some Techniques to Improve the Production

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How to cite this paper: Nombré, I., Kanazoé, I.W., Nasare, L.I., Nana, A. and Boussim, J.I. (2023) Shea Parklands Pollination in Burkina Faso, Some Techniques to Improve the Production. *Open Journal of Ecology*, **13**, 597-605.
https://doi.org/10.4236/oje.2023.139036

Received: July 29, 2023
Accepted: September 9, 2023
Published: September 12, 2023

Abstract

Shea tree is a major economic plant contributing to household income through the sale of edible fruits, kernels and shea butter. Shea butter is used industrially in the production of cosmetic products, chocolates and margarines. Fruits are used by human and also by birds. This study aimed to explore strategies for the improvement of shea yield through pollination. Two types of pollination (manual and natural pollination) were applied for the comparison of fruits set and their ripening. The fruits set and ripening index as well as average weight of ripe fruits and kernels were estimated. The results showed a significant difference between the fruits set Index of manual pollination and natural pollination ($H(1) = 33.437$, $p = 7.361 \times 10^{-9}$). Similarly, there was a significant difference between the ripening Index of manual pollination and natural pollination ($H(1) = 4.5113$, $p = 0.03367$). However, the mode of pollination did not influence the weight of ripe fruits and kernels. Therefore, the manual pollination enhances pollen supply to receptive stigmas for fertilization and improved fruit yield in *Vitellaria paradoxa*.

Keywords

Pollination Service, Shea Tree, Beekeeping, Foraging Activity, Pollinators, Burkina Faso

1. Introduction

The shea tree (*Vitellaria paradoxa* C. F. Gaertn) is a major multipurpose tree in the landscape in West Africa and according to [1] it is the dominant species in many parts of agroforestry production system for its several ecosystem functions. It also serves as refuge to migratory birds and wild bees that provide a di-

rect link between birds, bees and shea parklands [2].

According to the [3], the shea sector is one of the promising sectors identified by the various documents of policies and development strategies of Burkina Faso, a sector with potential for economic development, therefore likely to contribute to accelerating economic growth, the creation of local jobs and the fight against poverty, particularly of the most vulnerable groups, such as women and young if it is better valued. Burkina Faso in terms of shea, it is first of all 280,802,860 feet of shea trees with a production potential of shea kernels estimated at 1,247,295 tons per year. It produces shea butter used in diverse products such as cosmetics, chocolates and others confectionery. The sale of fruits, kernels and butter provides income for rural poverty alleviation and contribute to Sustainable Development Goals (SDG).

Unfortunately, several factors impact the production and the productivity of shea tree (*Vitellaria paradoxa*). Studies like those of [4] [5] [6] have shown that production depends on biotic and abiotic factors. Studies conducted by [7], on relationship between *vitellaria* and pollinators through three kinds of pollination have shown that production depends on pollination service. In addition [8] [9] have noted that *Vitellaria paradoxa* is melliferous plant species. And then, according to [10] [11], *Vitellaria paradoxa* dependence on insect pollination is evident in its breeding system and it is generally cross-pollinated [2] [12] [13].

The aim of this study is to highlight the role of pollinators notably honey bee *Apis mellifera* adansonii Lateille in shea tree production in Burkina Faso.

2. Material and Methods

2.1. Location of Study Areas

Torem village was located about 10 km North-East to the city of Pô, Capital of Nahouri Province. The Pô city is located on the coordinates 1˚09' West and 11˚11' North at an altitude of 321.5 m and bordering the North of Ghana (**Figure 1**).

The choice of the sites was based on the ability to have at least ten (10) shea trees with sufficient number of inflorescences likely to meet the requirements of the experiment.

2.2. Assessments of the Impact of Pollination on the Shea Tree Production

Two sites located at least 2 km apart were selected in the Torem village. In each site, ten (10) shea trees were randomly selected. On each plant, six (6) inflorescences were randomly selected. Two (2) pollination treatments (natural pollination and manual pollination) were applicated. Three (03) inflorescences per treatment were done. The natural pollination (open-pollination) had inflorescences unrestricted to pollination by insects. The manual pollination inflorescences were subjected to hand pollination. The buds initiating flowers of each were counted every fortnight as used in [7] [14] [15]. During the fruiting period,

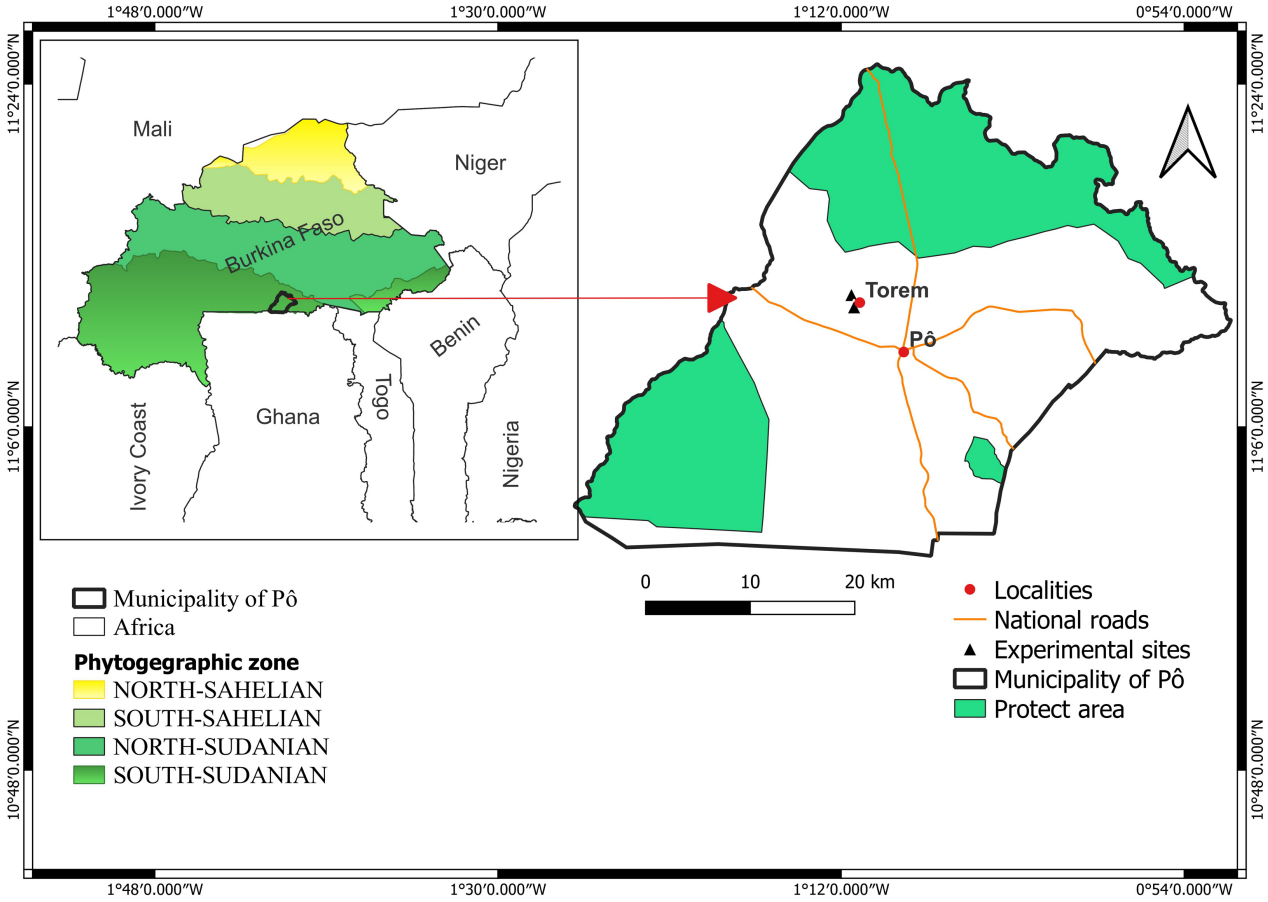

Figure 1. Location of study areas.

fruits set per inflorescence were recorded every two weeks until maturation. Matured fruits per inflorescence were harvested, counted and weighed with an electronic scale. The fruits were depulped and fresh nuts were dried during one (1) month before they were cracked, opened to remove kernels. The dry kernels per inflorescence were weighed also with an electronic scale.

2.3. Data Processing and Analysis

To determine the effect of pollination mode on fruits set, fruits set Index (In) was calculated per inflorescence according to the following formula: In = (N/F) where N is the number of fruits formed and F the number of flowers initially borne [16]. After that, Student test was carried out to check the normality of distribution of fruits set index. Student test was then performed to compare the fruits set index of manual pollination and natural pollination.

To determine the effect of fruits pollination mode on fruits ripening, ripening Index was calculated per inflorescence according to the following formula: Imr = (M/F) where M is the number of ripe fruits and F the number of fruits initially formed [17].

The Student test was carried out to verify the normality of the distribution of fruit ripening index. Since the data was not normally, distributed, a chi-Square

test was performed to compare the ripening index of the manual and natural pollinated.

To determine the effect of pollination mode on weight of ripe fruits and kernels the average weight of ripe fruits and kernels were calculated and then a comparison was made with the non-parametric T-test to determine the impact of the type of pollination on these different parameters.

3. Results

3.1. Effect of Pollination Mode on *Vitellaria paradoxa* Fruits Set

The mode of pollination influences the fruits set of *Vitellaria paradoxa*. There was a significant difference between the fruits set Index of manual pollination and natural pollination ($H(1) = 33.437$, $p = 7.361 \times 10^{-9}$).

The fruits set Index ranges from 0 - 0.83 for manual pollination whist that of natural pollination ranges between 0 and 0.17 (Figure 2).

3.2. Effect of Pollination Mode on *Vitellaria paradoxa* Fruits Ripening

The mode of pollination has a significant effect on the maturation of *Vitellaria paradoxa* fruits ($H(1) = 4.5113$, $p = 0.03367$). The ripening Index varies between 0.80 and 0 with a median of 0 for manual pollination whilst ripening Index of natural pollination ranges between 0.08 and 0 (Figure 3).

3.3. Effect of Pollination Mode on Ripe Fruits Weight of *Vitellaria paradoxa*

The mode of pollination did not significantly influence weight of mature fruits ($H(1) = 0.18756$, $p = 0.665$). The mean weight of mature fruit per inflorescence ranges from 9.29 to 40.71 g in manual pollination whilst that of natural pollination

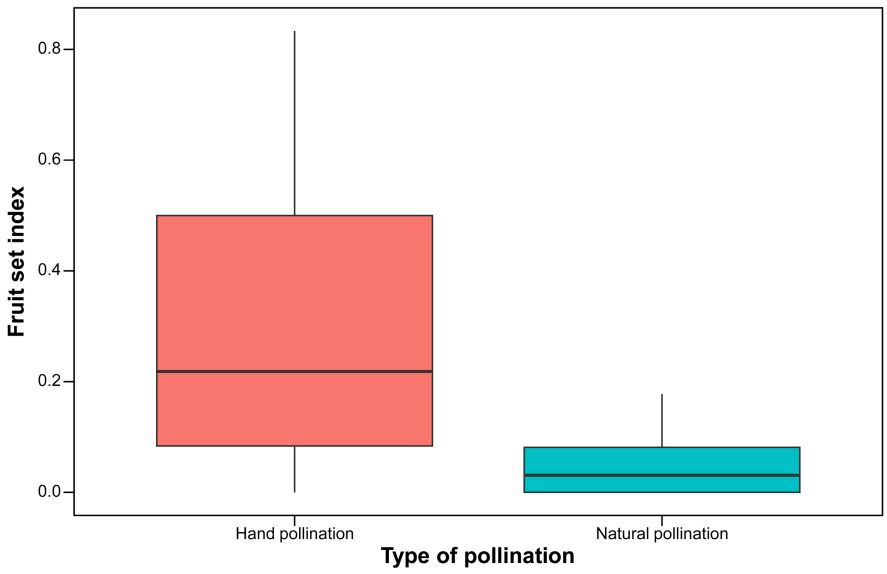

Figure 2. Fruits set Index in manual and natural pollination.

ranges from 11.04 - 34.46 g (Figure 4).

3.4. Effect of Pollination Mode on Kernel Weight of *Vitellaria paradoxa*

The mode of pollination did not signficantly influence the weight of kernels produced (H(1) = 1.0421, p = 0.3073). Kernel mean weight vary between 6.93 and 1.48 g with a median of 2.75 g for manual pollination whilst natural pollination ranges between 5.83 and 1.89 g with a median of 3.46 g (Figure 5).

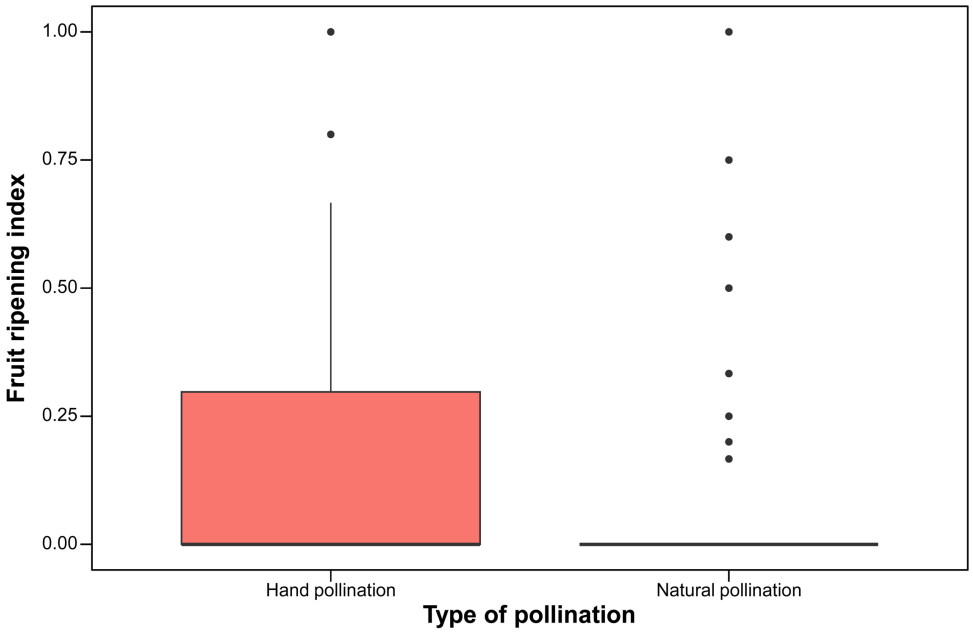

Figure 3. Fruits ripening Index of manual and natural pollination.

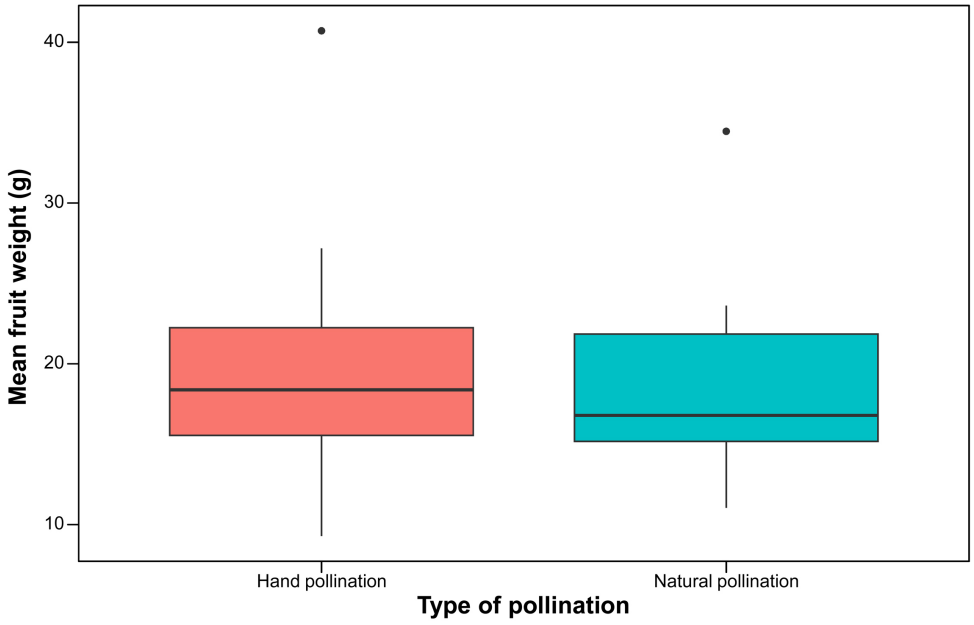

Figure 4. Mean weigth of fruits in manual and natural pollination.

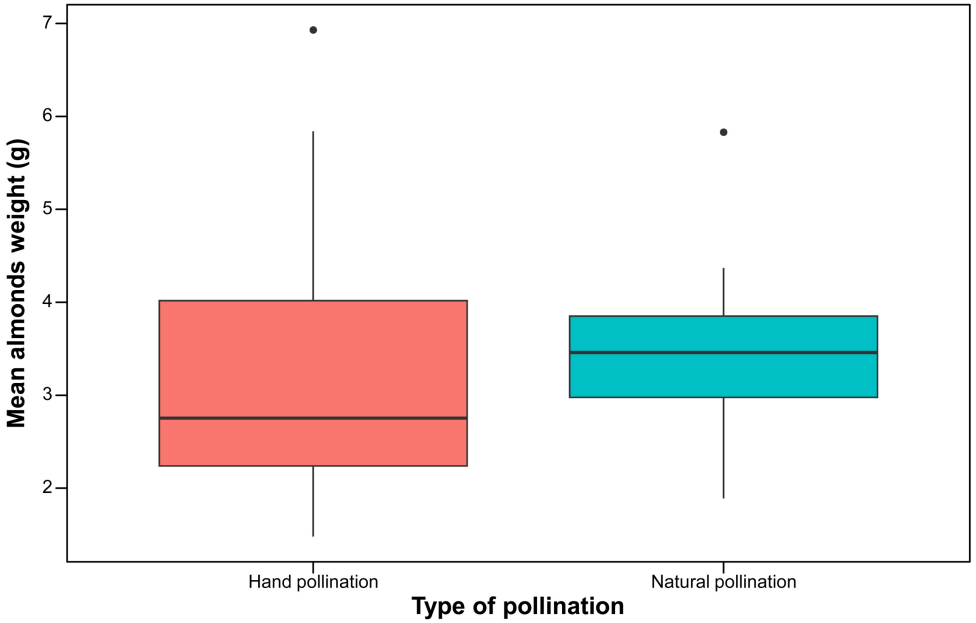

Figure 5. Mean weight of kernels in manual and natural pollination.

4. Discussion

The results highlighted the role of pollination on shea fruits set and their ripening. The analysis of the fruits set Index (In) reveals a statistically significant difference between the fruit set and maturation Index of manual pollination and natural pollination. These can be explained by several factors including the lack of pollination and the quantity and/or the quality of the pollen grains. And according to [4], the absence of pollination services results in abscission of mature flowers. The lack of pollination could be an outcome of several factors including the decline in pollinators population, the lack of floral or nesting resources required by insect pollinators in the local landscape [18] [19], poor beekeeping practices and climate change [8] [20]. These results emphasis the importance of pollination in *Vitellaria paradoxa* fruiting [7].

The quantity and quality of the pollen deposited on the the stigma of the gynoecium can also be factors limiting pollination. Several studies have revealed that the success of sexual reproduction in plants is limited by the amount of pollen deposited on the stigma [21] [22]. The high fruits set and ripening Index of manual pollination would be linked to a significant supply of pollen on the stigma, which would increase the chance to have germinated pollen and promote better pollen selection [2] [23].

The significant effect of manual pollination would therefore be linked to the high contribution of pollen from other shea trees (cross pollinating) as well as the quality of the pollen provided.

The results revealed that the average weight of the fruits and kernels is significantly influenced by pollination mode. Our results seem to indicate that the type of pollination only influences the quantity (number) of fruits produced but

not the weight (quality) of the fruits. This collaborated the findings of [7], where there was no significant difference in fruits and seeds weight between hand and open pollinated treatments.

5. Conclusion

These results show that pollinators influence fruiting and ripening of shea. Indeed, the lack of pollinators limits pollen transport resulting in non-fertilization of flowers and leading to low fruits production, whereas, the massive presence of pollen on the stigma due to manual pollination, induces fertilization, fruiting and fruits ripening. This challenges us to actions to strengthen the roles of pollinators by protecting pollinators and their nests by developing living spaces, and adopting of modern apiculture technique for enhancing pollinators population. The fruits are also eaten by birds and that increases the relationship between bees, birds and shea trees in particular and the biodiversity in general.

Acknowledgements

We thank the Non-Governmental Organizations "Association des amis de la nature" (NATURAMA) and BirdLife International who funded this work. We thank also the NATURAMA teams and the inhabitants of Torem village for their assistance.

Author Contributions

All the authors have contributed to the field work, the data analysis, the manuscript writing and have given their consent for publication.

Conflicts of Interest

The authors declare no known conflicting interests.

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