Journal of Experimental Agriculture International

Volume 46, Issue 7, Page 903-908, 2024; Article no.JEAI.118999
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Study on the Effect of Bee Attractants on the Giant Honey Bee, *Apis dorsata* and their Effect on Niger [*Guizotia abyssinica* (L.f.) Cass] Seed Yield

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jeai/2024/v46i72644

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/118999

Original Research Article

Received: 25/04/2024
Accepted: 29/06/2024
Published: 04/07/2024

ABSTRACT

The study was conducted at the experimental farm of the PC Unit Sesame and Niger, CoA, Jawaharlal Nehru Krishi Vishwa Vidyalaya, located in Jabalpur, Madhya Pradesh, during the *Kharif* season of 2022. The primary objective of the experiment was to assess the influence of bee

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Cite as: *Dwarka, Anand Kumar Panday, Shobharam Thakur, and Vijay Kumar Katara. 2024. "Study on the Effect of Bee Attractants on the Giant Honey Bee, Apis Dorsata and Their Effect on Niger [Guizotia Abyssinica (L.F.) Cass] Seed Yield". Journal of Experimental Agriculture International 46 (7):903-8. https://doi.org/10.9734/jeai/2024/v46i72644.*

attractants on the attraction of *Apis dorsata* (giant honey bees) and their subsequent impact on the seed yield of niger crop. The experiment was designed using a Randomized Block Design (RBD) with nine treatments and three replications. This experimental setup allows for systematic testing of the effects of different bee attractants on both bee behaviour and crop yield while controlling for potential sources of variation. By utilizing this design, researchers can obtain reliable data on the efficacy of various bee attractants in enhancing pollination and improving seed yield in niger crops. Treatment used T_1: Flower extract of *Madhuca longifolia* 10%, T_2: Juice of *Sachharum officinarum* 10%, T_3: Jaggery solution 10%, T_4: Honey solution 10%, T_5: Fruit extract of *Foenix dactylifera* 10%, T_6: Sugar solution 10%, T_7: Rose water (marketed) 10%, T_8: Water spray and T_9: Control. The results showed that the both at 10% and 50% flowering stage *Apis dorsata* visit was numerically the highest with flower extract of mahua, *Madhuca longifolia* 10% with 15.67 and 10.33 *Apis dorsata*/m^2/5min, respectively. This was followed by fruit extract of date palm, *F. dactylifera* spray with 14.92 and 9.75 *Apis dorsata*/m^2/5min, respectively. The population of *Apis dorsata* was received from the controlled condition 2.67 and 3.25 *Apis dorsata*/m^2/5min at 10% and 50% flowering stage, respectively. This was followed by water spray 5.08 and 5.16 *Apis dorsata*/m^2/5min at 10% and 50% flowering stage, respectively. The foliar spray of flower extract of *M. longifolia* and fruit extract of *F. dactylifera* 10% were found significantly superior over others in respect to record higher seed yield and recorded 6.96 q and 6.90 q/ha seed yield, respectively.

Keywords: F. dactylifera; Madhuca longifolia; Apis dorsata; Bee attractants; Niger.

1. INTRODUCTION

"Niger, scientifically known as *Guizotia abyssinica*, is a crop primarily cultivated for its seeds, which are rich in oil and protein. It's commonly referred to as Niger seed, ramtil, or black seed. Niger is native to Ethiopia and has been cultivated for centuries in various parts of Africa and South Asia. It is known with different names in different part of the country *viz., jagni* or *jatangi* (Hindi); *ramtal* or *kharsani* (Gujarati); *karale* or *khurasani* (Marathi); *uhechellu* (Kannada); *payellu* (Tamil); *verrinuvvulu* (Telugu); *alashi* (Oriya); *sarguza* (Bengali); and *sorguja* (Assamese)" [1]. "In Madhya Pradesh it is mainly cultivated by resource-poor farmers, notably in the tribal regions of Kymore Plateau Zone of districts of Chhindwara, Dindori, Mandla, Seoni, Jabalpur and Shahdol. It is an annual (3-4 months crop) herbaceous plant with branches and height up to 1.8 metres. Niger seed contains 32 to 40% of quality oil with 18 to 24% protein. Niger seed oil is free from antinutrients and rich in (70% linoleic acid) essential fatty acids" [1]. The statistics you provided further underscore the significance of Niger seed in the agricultural landscape. With an average yield of 357.2 kg per hectare and a total production of 40.3 thousand tonnes, Niger seed is cultivated across 112.8 thousand hectares in India. Notably, Madhya Pradesh plays a substantial role in Niger cultivation, dedicating approximately 16.0 thousand hectares to this crop. This highlights the region importance in the overall production and supply of Niger seeds in the country [2]. Niger oil, extracted from Niger seeds, is characterized by its pale yellow color, nutty flavor, and pleasant aroma. It boasts a protein content ranging from 18 to 24% and a high-quality oil content of 32-40%, making it highly valued. Notably, the oil has a taste reminiscent of desi ghee, and the seeds are free from harmful toxins. This multifaceted utility underscores the importance of Niger cultivation in India agricultural and economic landscape, particularly for tribal communities that rely on it for sustainance and livelihood [3]. Niger, being a self-incompatible plant, relies entirely on cross-pollination for successful seed production. Insect pollination, particularly by bees, is crucial for ensuring optimal seed yields and enhancing the quality of the crop. This reliance on insect pollinators underscores the importance of maintaining healthy populations of pollinating insects for sustainable Niger cultivation and agricultural productivity overall [3]. This type of research is significant as it helps in understanding the role of bee attractants in pollination and its subsequent effects on crop yield. Bees, *A. dorsata*, play a crucial role in pollination, which is essential for the reproduction of many plants, especially those that produce seeds. By studying the effects of different attractants on bee behaviour and their impact on seed yield, researchers can potentially identify methods to enhance pollination and improve crop productivity.

2. MATERIALS AND METHODS

The research was conducted during the *Kharif* season of 2022 at the experimental farm of the PC Unit (ICAR) Sesame and Niger, College of

Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, located in Jabalpur, Madhya Pradesh. The study focused on investigating the impact of bee attractants on the foraging behaviour of rock honey bees in Niger crops. The research was structured using a randomized block design, a common experimental design in agricultural research, with three replications. Jabalpur, a city in Madhya Pradesh, is situated on the bank of Narmada river geographically located between 22° 49" and 24° 8" North latitude and 78° 21" East longitude and at an altitude of 411.78 m. above the mean sea level. The Jabalpur comes under semi-humid and sub-tropical climate. It is in the agro-climatic zone of Kymore Plateau and Satpura Hills. The mean annual rainfall is nearly 1423 mm, which is received by South west monsoon. The mean maximum temperature recorded in months of May-June varies from 45.5 °C to 48.4 °C, while the average minimum temperature varied between 6.2° C to 8.7°C during December-January that are the coldest months of the year.

The attractants were sprayed twice, first at the 10 per cent flowering stage and then at the 50 per cent flowering stage. The recommended agronomical practices were followed to ensure a good seed production plot, and spraying of insecticides was avoided during the flowering stage of the crop. In each plot, a one-meter square area was randomly selected, and the number of pollinators visiting the flowers was recorded. Observations were made a day before the first spraying, and then on the 1st, 3rd, 5th and 7th days after both the first and second sprayings.

3. RESULTS AND DISCUSSION

The current study findings show that the capacity of *A. dorsata* to forage in the Niger crop was significantly impacted by each bee attractant sprayed. The attractants exhibited superior performance compared to the control group in all recorded criteria. This indicates that the bee attractants evaluated were effective in attracting rock honey bees to the Niger crop, potentially leading to increased pollination activity and higher crop output. The results underscore the importance of using bee attractants as a strategy to enhance agricultural output and pollination efficiency, particularly when cultivating crops in regions like the Niger Delta. Further, research into the specific effects of each attractant and their long-term impact on crop productivity provide valuable insights into optimizing pollination management in agricultural settings. The study findings show that every treatment used significantly influenced the number of *A. dorsata* that were attracted. This implies that the various treatments had variable degrees of effect on the bees attraction, demonstrating the potency of the different techniques or materials employed as attractants. These discoveries are critical to our understanding of how various attractants can affect bee behaviour and their presence in agricultural environments. In particular, for Niger crops, where bee pollination is critical, researchers can develop methods to improve crop productivity by determining which treatments are most successful in attracting *A. dorsata*. Extensive examination of the distinct attributes and outcomes of each intervention can yield significant understanding for enhancing bee attractant techniques in support of sustainable farming approaches.

At 10% flowering stage giant honey bee visit was numerically the highest with treatment, flower extract of *M. longifolia* 10% (15.67/m^2/5min) followed by (10.33/m^2/5min) lated to the fruit extract of *F. dactylifera* 10% (14.92/m^2/5min) while it was the lowest at control (2.67/m^2/5min) followed by water spray (5.08/m^2/5min) and 10% sugar solution (9.67/m^2/5min). At 50% flowering stage the highest population of *A. dorsata* was attracted with flower extract of *M. longifolia* 10% (10.33/m^2/5min) followed by (9.75/m^2/5min) fruit extract of *P. dactylifera* while it was least on controlled condition (2.75/m^2/5min) followed by water spray (5.00/m^2/5min) and 10% sugar solution spray (8.33/m^2/5min). Present findings are also supported by the findings of Nidagundi [4], who reported that spraying cacambe at (10 per cent), Bee-Q at (1.25 per cent) and jaggery solution at (10 per cent) enhanced bee visitation to the flowers of bitter gourd. These findings are in close conformity with the earlier reports of Dwarka et al*.,* [1], who reported that the 10% and 50% flowering stages of the Niger crop, the highest number of visits by giant honey bee were observed with the treatment of *M. longifolia* flower extract at 10%. Specifically, during the 10% flowering stage, there were 50.71 giant honey bees per square meter per 5 minutes, while during the 50% flowering stage, this number increased to 52.46 giant honey bees per square meter per 5 minutes. Following closely behind the mahua flower extract treatment, the next highest number of visits were recorded with the treatment of rose water spray. During the 10% flowering stage, there were 43.58 giant honey bees per square meter per 5 minutes, and during the 50% flowering stage, this number slightly increased to 44.96 giant honey bees per

Table 1. Effect of different attractants on the attraction of giant honey bee, *Apis dorsata* and their impact of seed yield in Niger crop 2022

Treatment	Population of *Apis dorsata*/m²/5 Minutes												Yield (q/ha)
	1st Spray at 10% Flowering						2nd Spray at 50% Flowering						
	1DBS	Days After Spray				Mean	1DBS	Days After Spray				Mean	
		1DAS	3DAS	5DAS	7DAS			1DAS	3DAS	5DAS	7DAS		
T_1-Flower extract of *M. longifolia* 10%	7.00 (2.73)	13.00 (3.49)	19.33 (4.43)	17.33 (4.19)	13.00 (3.65)	15.67 (4.02)	3.67 (2.02)	8.33 (2.97)	8.00 (2.91)	13.67 (3.74)	11.33 (3.41)	10.33 (3.28)	6.96 (2.73)
T_2-Juice of *S. officinarum* 10%	8.67 (2.99)	13.67 (3.72)	15.67 (4.02)	13.67 (3.72)	9.00 (3.03)	13.00 (3.66)	6.00 (2.51)	8.00 (2.89)	11.33 (3.44)	7.33 (2.75)	7.00 (2.73)	8.42 (2.98)	6.00 (2.55)
T_3-Jaggery solution 10%	6.33 (2.58)	17.33 (4.12)	14.33 (3.83)	12.00 (3.50)	11.00 (3.35)	13.67 (3.74)	6.00 (2.54)	6.67 (2.66)	10.67 (3.29)	9.67 (3.19)	9.00 (3.08)	9.00 (3.07)	4.50 (2.24)
T_4-Honey solution 10%	6.00 (2.53)	16.67 (4.11)	14.00 (3.77)	12.67 (3.60)	8.67 (3.00)	13.00 (3.65)	6.33 (2.56)	7.67 (2.85)	11.33 (3.44)	8.00 (2.83)	7.33 (2.77)	8.58 (3.01)	5.55 (2.46)
T_5- Fruit extract of *F. dactylifera* 10%	7.67 (2.84)	15.33 (3.98)	16.00 (4.02)	14.67 (3.89)	13.67 (3.71)	14.92 (3.92)	5.67 (2.40)	8.67 (3.02)	10.00 (3.05)	10.33 3.29)	10.00 (3.15)	9.75 (3.18)	6.90 (2.72)
T_6-Sugar solution 10%	5.33 (2.39)	6.67 (2.64)	8.67 (2.76)	16.33 (4.07)	7.00 (2.60)	9.67 (3.15)	7.00 (2.71)	7.33 (2.80)	10.33 (3.28)	8.00 (2.87)	7.67 (2.86)	8.33 (2.97)	6.42 (2.63)
T_7-Rose water 10%	8.00 (2.90)	16.33 (4.10)	15.67 (4.00)	12.00 (3.47)	11.67 (3.41)	13.92 (3.78)	6.67 (2.62)	6.00 (2.54)	9.00 (2.98)	10.33 (3.24)	9.33 (3.13)	8.67 (3.03)	6.08 (2.56)
T_8-Water spray	5.33 (2.40)	4.67 (2.26)	7.33 (2.80)	4.67 (2.26)	3.67 (2.00)	5.08 (2.36)	3.67 (2.04)	4.33 (2.18)	5.33 (2.41)	5.00 (2.34)	5.33 (2.40)	5.00 (2.34)	5.16 (2.38)
T_9-Control	2.33 (1.66)	3.67 (2.03)	1.67 (1.44)	3.33 (1.79)	2.00 (1.56)	2.67 (1.77)	2.00 (1.56)	3.00 (1.86)	3.33 (1.95)	2.67 (1.77)	2.00 (1.47)	2.75 (1.80)	3.25 (1.92)
SEm±	0.24	0.44	0.40	0.38	0.37	0.22	0.29	0.18	0.38	0.31	0.27	0.12	0.03
CD at 5%	0.72	1.32	1.21	1.14	1.11	0.67	0.88	0.53	1.13	0.91	0.80	0.37	0.10

**Figures in parenthesis are square root of √ x+0.5*

square meter per 5 minutes. The population of giant honey bee was received from controlled condition 15 and 17.21 giant honey bees/m^2/5 min at 10% and 50% flowering stage, respectively. This was followed by water spray 18.67 and 19.76 giant honey bees/m^2/5min at 10% and 50% flowering stage, respectively on Niger. Present findings are corroborated with the findings of Kalmath and Sattigi [5], who reported that spraying of cacambe (10 per cent) and jaggery (10 per cent) attracted maximum number of *A. dorsata* up to 15 days after first and second spray. Present findings are corroborated with the findings of Dwarka *et al.,* [6], who reported that at 10% and 50% flowering stage *A. dorsata* visit was numerically the highest with flower extract of *Madhuca longifolia* 10% with 20.42 and 19.25 *A. dorsata*/m^2/5min, respectively.

3.1 Seed Yield (q/ha)

This underscores the importance of considering the specific treatments when analyzing seed yield data. The highest seed yield (6.96 q/ha) was recorded with the treatment involving a foliar spray of 10% flower extract of *M. longifolia*. This was followed by a yield of 6.90 q/ha from a 10% fruit extract of *F. dactylifera* spray and 6.42 q/ha from a 10% sugar solution spray. In contrast, the lowest seed yield (3.25 q/ha) was observed under controlled conditions, with a slightly higher yield of 5.16 q/ha recorded from a 10% water spray. The findings of your study align with those of Chandrashekhar and Sattigi [7], who observed similar results regarding the efficacy of bee attractants in enhancing both quantitative and qualitative parameters of radish seed. Chandrashekhar and Sattigi [2], found that the spraying of bee attractants such as cacambe (10%) and jaggery solution (10%) significantly improved various aspects of radish seed production. Present findings are closely corroborated with the findings of Dwarka et al.,[6], who reported that the foliar spray of 10% flower extract of *M. longifolia* and rose water 10% were found significantly superior over others in respect to record higher seed yield and recorded 6.90 q/ha and 6.70 q/ha seed yield, respectively [8,9].

4. CONCLUSION

The study findings suggest that *M. longifolia* flower extract at a concentration of 10%, applied during both the 10% and 50% flowering stages, was the most effective in attracting *A. dorsata*. Following closely behind, rose water at a concentration of 10% also demonstrated high effectiveness in attracting *A. dorsata* and resulted in a higher seed yield compared to other treatments. These results indicate the strong potential of *M. longifolia* flower extract and rose water as effective bee attractants for enhancing pollination activity, particularly by *A. dorsata*, in agricultural settings.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

Details of the AI usage are given below:

1. ChatGPT.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/118999