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EFFECT OF BEE ATTRACTANTS ON FORAGING BEHAVIOUR OF *APIS FLOREA* AND PRODUCTIVITY OF NIGER, *GUIZOTIA ABYSSINICA* (L.F.) CASS

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ABSTRACT

A field experiment was conducted during *Kharif* 2022 at the Experimental Farm, PC Unit Sesame & Niger, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh, India, to evaluate the efficacy of different bee attractants in enhancing the foraging activity of *Apis florea* and their subsequent effect on seed yield of niger. The results indicated that the response of *Apis florea* varied considerably with the type of attractant and flowering stage. At 10% flowering, the highest bee visitation was observed in plots receiving 10% flower extract of *Madhuca longifolia*, with 14.67 individuals m^{-2} 5 min^{-1}. At 50% flowering, maximum visitation was recorded with 10% *Phoenix dactylifera* fruit extract, registering 14.00 individuals m^{-2} 5 min^{-1}. Rose water at 10% concentration and 10% sugar solution also promoted substantial bee activity, recording 13.75 and 13.67 individuals m^{-2} 5 min^{-1}, respectively. In comparison, the untreated control recorded only 5.00 and 3.50 individuals m^{-2} 5 min^{-1} at 10% and 50% flowering, respectively, whereas water spray resulted in 7.33 and 4.75 individuals m^{-2} 5 min^{-1}. A significant improvement in niger seed yield was also observed with the application of selected attractants. Foliar spraying of 10% *Madhuca longifolia* flower extract, 10% *Phoenix dactylifera* fruit extract, and 10% rose water produced 6.96, 6.90, and 6.42 q ha^{-1} seed yield, respectively, and were statistically superior to the other treatments. The study therefore indicated that natural flower and fruit extracts, particularly *Madhuca longifolia* and *Phoenix dactylifera*, can effectively increase *A. florea* visitation during niger flowering and contribute to enhanced seed productivity.

KEYWORDS: Foliar spray, *Apis florea*, significantly superior, fruit extract of *Phoenix dactylifera* and 10% and 50% flowering stage.

INTRODUCTION

Niger, *Guizotia abyssinica* (L. f.) Cass., is an important oilseed species belonging to the family Asteraceae (Compositae) and is indigenous to Tropical Africa. In India, the crop has considerable importance in the livelihood of tribal communities and is often regarded as a lifeline of tribal agriculture and rural economy. It is predominantly cultivated by tribal farmers on marginal and sub-marginal soils under rainfed conditions, generally with very limited external inputs (Ranganatha *et al.,* 2009). During 2021–22, niger occupied approximately 112.8 thousand hectares in India and produced about 40.3 thousand tonnes, with a mean productivity of 357.2 kg ha^{-1}. Madhya Pradesh accounted for nearly 16.0 thousand hectares, producing 4.9 thousand tonnes with an average seed productivity of 308.8 kg ha^{-1} (Anonymous, 2021–22). Niger is primarily cultivated for its edible oil, contributing nearly 3% of the total edible oil requirement of India (Getinet and Sharma, 1996). The seeds generally contain approximately 32–40% oil and 18–24% protein. Niger oil is characterized by a pale-yellow colour, pleasant odour and a distinctive nutty flavour (Dwarka *et al.,* 2024a,b,c,d,e). Both the seed and its extracted oil are considered free from toxic constituents, while the flavour and palatability of the oil are often compared with those of traditional desi ghee. These nutritional and culinary attributes enhance the economic significance of niger as an oilseed crop, particularly in regions where it is cultivated under low-input conditions. Niger is a self-incompatible species and is predominantly dependent on cross-pollination, with insect-mediated pollination playing a crucial role in successful seed production (Dwarka *et al.,* 2022). Effective insect pollination can substantially enhance not only seed yield but also several yield-associated attributes and seed quality in cross-pollinated crops such as niger. Adequate pollination may further contribute to relatively synchronized crop maturity and facilitate timely harvesting. Therefore, ensuring the availability of suitable pollinators during the flowering phase represents an important agronomic intervention

for maximizing the reproductive efficiency of niger (Dwarka et al., 2022). The strategic placement or maintenance of bee colonies within niger-growing areas can provide an effective means of improving pollination efficiency. At the national level, systematic utilization of honey bees for crop pollination could potentially contribute to increasing oilseed production and thereby assist in reducing the deficit between domestic edible-oil demand and supply without necessarily requiring a proportional expansion of the area under oilseed cultivation (Mohana Rao *et al.,* 1981). Earlier investigations concerning the contribution of honey bees and other natural pollinators have demonstrated substantial reductions in niger seed yield, ranging from approximately 11 to 78%, when effective pollinator activity was absent. In addition to increased crop production, integration of beekeeping with niger cultivation has been reported to provide supplementary economic returns, with additional income estimates ranging from Rs. 252 to Rs. 2,125, including approximately Rs. 1,015 ha^{-1} attributable to honey production in comparison with open-pollinated crops (Anonymous, 2005).

Among the different insect pollinators, honey bees are widely recognized as highly efficient and reliable agents of pollination. Nevertheless, the effectiveness of managed honey bee pollination depends greatly on the ability of bees to preferentially visit the target crop rather than alternative floral resources available in the surrounding environment. Consequently, techniques that enhance the attractiveness of the crop to bees can play an important role in improving pollinator visitation and, ultimately, reproductive success. Several commercial and locally prepared bee attractants, including Bee-Line, Bee-Here, Bee-Scent, Bee-Scent Plus, Fruit Boost, Bee-Q, sugar solution, sugarcane juice, jaggery solution and molasses, have been utilized to stimulate bee foraging activity in niger-growing regions of Jabalpur, Madhya Pradesh (Dwarka e*t al.,* 2022; 2023a,b,c). Such attractants may modify the olfactory and nutritional cues associated with the crop and thereby encourage pollinators to remain longer within the flowering area. However, systematic information concerning the comparative effectiveness of different bee attractants under Indian agro-ecological conditions remains relatively limited.

In view of the increasing importance of insect pollinators in sustaining crop productivity, their conservation, enhancement and scientific management have become important components of sustainable crop production. Enhancing the visitation of efficient pollinators such as *Apis florea* through suitable attractants may provide a practical approach for improving pollination services in niger. Therefore, the present investigation was undertaken to evaluate the influence of different bee attractants on the visitation and foraging activity of *Apis florea* and to determine their subsequent effect on seed yield of niger under field conditions.

2. METHOD

The present investigation was conducted at Jabalpur, Madhya Pradesh, India, a prominent city situated along the banks of the Narmada River. Geographically, the city lies between 22°49′ and 24°08′ N latitude and at approximately 78°21′ E longitude, with an elevation of about 411.78 m above mean sea level. The field experiment was carried out during the *Kharif* season of 2022 at the Experimental Farm of the PC Unit (ICAR) Sesame and Niger, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh. The experiment was designed to assess the influence of different bee attractants on the foraging activity and visitation behaviour of *Apis florea* in niger under field conditions. The treatments were evaluated using a RBD with three replications to ensure reliable assessment of treatment effects and experimental variability.

Table. 1: List of attractants

Sl. No.	Treatments/attractants
1.	T1- Flower extract of *Madhuca longifolia* 10%
2.	T2 –Juice of *Sachharum officinarum* 10%
3.	T3 -Jaggery solution 10%
4.	T4 -Honey solution 10%
5.	T5 -Fruit extract of *Phoenix dactylifera* 10%
6.	T6-Sugar solution 10%
7.	T7 -Rose water (Marketed) 10%
8.	T8 -Water spray.
9.	T9-Control

Each of the selected bee attractants was applied as a foliar spray on two occasions, corresponding to the 10% and 50% flowering stages of the niger crop. All recommended agronomic practices were adopted uniformly throughout the experimental period to maintain healthy and vigorous crop growth. For assessing the response of *Apis florea*, a randomly selected area of 1 m^2 was marked in each experimental plot, and the number of bees visiting the flowers within this area was counted during the designated observation period.

Bee visitation was monitored one day prior to each spray application and subsequently on the 1st, 3rd, 5th and 7th days after spraying. The same observation schedule was followed after both applications at the respective flowering stages. At crop maturity, seed yield from each treatment was harvested and recorded separately for comparative evaluation of treatment performance. The collected insect specimens were subsequently submitted for taxonomic confirmation and identification with the assistance of the Regional Centre, Zoological Survey of India (ZSI), Jabalpur, Madhya Pradesh.

3. RESULTS AND DISCUSSION

The findings of the present field investigation demonstrated that foliar application of the tested bee attractants significantly influenced the foraging behaviour and floral visitation of *Apis florea* in niger. In general, the attractant-treated plots

exhibited greater bee activity than the untreated control, indicating that the application of suitable attractant substances can enhance the visitation of pollinating insects to niger flowers.

Significant differences were observed among the various treatments with respect to the abundance of Apis florea at both flowering stages. During the 10% flowering stage, the maximum bee visitation was recorded in the treatment receiving 10% flower extract of *Madhuca longifolia*, where 14.67 individuals m^{-2} 5 min^{-1} were observed. The next best response was obtained with 10% fruit extract of Phoenix dactylifera, which attracted 14.00 individuals m^{-2} 5 min^{-1}, followed by 10% rose water with 13.75 individuals m^{-2} 5 min^{-1}. In contrast, the lowest bee visitation was recorded in the untreated control, with only 5.00 individuals m^{-2} 5 min^{-1}. Water spray resulted in 7.33 individuals m^{-2} 5 min^{-1}, whereas 10% honey solution attracted 10.25 individuals m^{-2} 5 min^{-1}.

A similar trend was evident at the 50% flowering stage, although the magnitude of bee visitation varied among the treatments. The highest number of A. florea individuals was recorded with 10% flower extract of *M. longifolia* (13.50 individuals m^{-2} 5 min^{-1}), followed by 10% fruit extract of *P. dactylifera* (11.75 individuals m^{-2} 5 min^{-1}) and 10% rose water (11.25 individuals m^{-2} 5 min^{-1}). Application of 10% *Saccharum officinarum* juice also resulted in comparatively higher bee activity, recording 10.25 individuals m^{-2} 5 min^{-1}. The untreated control registered the minimum visitation of 3.50 individuals m^{-2} 5 min^{-1}, followed by water spray with 4.75 individuals m^{-2} 5 min^{-1} and 10% jaggery solution, which recorded 7.25 individuals m^{-2} 5 min^{-1}.

The greater visitation recorded in attractant-treated plots may be associated with the presence of volatile aromatic compounds and readily available soluble sugars that provide olfactory and nutritional cues to foraging bees. Among the tested treatments, *M. longifolia* flower extract consistently exhibited a strong attractant effect, suggesting its potential utility for enhancing pollinator activity during the flowering period of niger.

The present observations are in agreement with Singh (2015), who reported active visitation of bees, including *Apis florea*, on flowering crops. Similarly, Manchare *et al.* (2019) demonstrated the effectiveness of sugar-based attractants in increasing honey bee activity. They reported that 10% honey solution showed the highest attraction of *Apis cerana* indica, with an average visitation of 2.32 bees m^{-2} min^{-1}, followed by 10% jaggery solution (2.16 bees m^{-2} min^{-1}) and 10% molasses (2.04 bees m^{-2} min^{-1}). Thus, the present findings further support the potential of attractant-based approaches for manipulating bee foraging behaviour and improving pollination services in niger.

3.3. Seed yield (q/ha)

The analysis of seed yield demonstrated significant variation among the different bee-attractant treatments. The application of attractants during the flowering period resulted in considerable improvement in seed production compared with the untreated control. Among the evaluated treatments, the maximum seed yield of 6.96 q ha^{-1} was obtained from the treatment receiving foliar application of the 10% flower extract of *Madhuca longifolia*. This was closely followed by 10% rose water, which produced 6.90 q ha^{-1}, while the application of 10% sugar solution resulted in a seed yield of 6.08 q ha^{-1}.

The lowest seed yield, 3.25 q ha^{-1}, was obtained under the control condition where no attractant was applied and effective pollinator activity was absent. Water spray performed comparatively better than the control and produced 5.16 q ha^{-1} seed yield. The considerable difference between treated and untreated plots suggests that enhancement of pollinator visitation during the flowering phase can contribute substantially to reproductive success and final seed production in niger.

The present results are supported by the observations of Chandrashekhar and Sattigi (2009), who demonstrated that application of bee-attracting substances, particularly 10% cacambe and 10% jaggery solution, significantly improved both quantitative and qualitative characteristics of radish seed. Similar evidence was reported by Dwarka *et al.* (2022), who recorded a maximum niger seed yield of 6.90 q ha^{-1} following foliar application of 10% *Madhuca longifolia* flower extract. The present findings are also consistent with the reports of Jayaramappa *et al.* (2011) and Dwarka *et al.* (2023a,b,c), which collectively indicate that enhanced bee activity through suitable attractants can improve pollination efficiency and contribute to greater seed yield in cross-pollinated seed crops.

The results indicate that bee attractants, particularly floral extracts and sugar-based formulations, have considerable potential for enhancing pollinator activity and improving seed productivity in niger under field conditions.

Plate: 1. Experimental field

Treatment	Population of *Apis florea*/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	
T1-Flower extract of *M. longifolia* 10%	6.33 (2.61)	13.33 (3.71)	14.33 (3.76)	20.33 (4.56)	10.67 (3.34)	14.67 (3.89)	8.00 (2.86)	11.00 (3.39)	14.00 (3.81)	14.67 (3.86)	11.67 (3.48)	13.50 (3.65)	6.96 (2.73)
T2-Juice of *S. officinarum* 10%	4.33 (2.18)	11.33 (3.41)	11.00 (3.35)	15.67 (3.98)	8.67 (3.02)	11.67 (3.49)	6.33 (2.60)	9.33 (3.09)	10.33 (3.27)	11.33 (3.44)	9.33 (3.13)	10.25 (3.25)	6.00 (2.55)
T3-Jaggery solution 10%	3.33 (1.94)	14.33 (3.84)	15.00 (3.90)	13.33 (3.70)	9.67 (3.18)	13.08 (3.68)	5.67 (2.48)	6.67 (2.62)	9.67 (3.18)	10.33 (3.28)	8.67 (3.03)	7.25 (3.05)	4.50 (2.24)
T4-Honey solution 10%	2.67 (1.77)	8.00 (2.90)	11.67 (3.48)	14.33 (3.84)	7.00 (2.72)	10.25 (3.28)	5.00 (2.34)	7.33 (2.76)	8.67 (3.01)	10.67 (3.33)	6.67 (2.66)	9.00 (2.97)	5.55 (2.46)
T5- Fruit extract of *P. dactylifera* 10%	4.67 (2.27)	11.67 (3.48)	15.00 (3.91)	17.00 (4.18)	12.33 (3.58)	14.00 (3.81)	8.67 (3.02)	10.00 (3.24)	11.00 (3.38)	14.00 (3.81)	10.33 (3.29)	11.75 (3.44)	6.42 (2.63)
T6-Sugar solution 10%	5.33 (2.41)	12.33 (3.57)	12.00 (3.53)	18.67 (4.37)	11.67 (3.45)	13.67 (3.76)	5.67 (2.46)	7.67 (2.86)	9.33 (3.13)	11.33 (3.43)	7.67 (2.85)	7.50 (3.08)	6.08 (2.56)
T7-Rose water 10%	2.33 (1.68)	10.33 (3.29)	15.67 (4.02)	19.33 (4.44)	9.67 (3.18)	13.75 (3.77)	7.00 (2.73)	8.00 (2.81)	10.67 (3.34)	13.00 (3.63)	12.00 (3.53)	11.25 (3.38)	6.90 (2.72)
T8-Water spray	2.00 (1.58)	7.00 (2.71)	7.33 (2.78)	11.00 (3.38)	4.00 (2.11)	7.33 (2.80)	3.33 (1.95)	4.00 (2.03)	6.00 (2.54)	7.00 (2.71)	4.33 (2.20)	4.75 (2.41)	5.16 (2.38)
T9-Control	1.33 (1.34)	4.33 (2.09)	5.00 (2.34)	7.00 (2.72)	3.67 (2.02)	5.00 (2.32)	1.67 (1.44)	3.00 (1.86)	3.67 (2.00)	4.00 (2.11)	3.00 (1.86)	3.50 (1.98)	3.25 (1.92)
SEm±	0.12	0.26	0.31	0.21	0.20	0.11	0.20	0.35	0.20	0.25	0.12	0.09	0.03
CD at 5%	0.37	0.78	0.94	0.63	0.61	0.32	0.59	1.03	0.60	0.74	0.36	0.28	0.10

Table 2: Effect of different attractants on the attraction of *Apis florea* and their impact of seed yield in niger crop *Kharif*.

Plate: 2. 10% flowering stage

Plate: 3. 50% flowering stage

4. CONCLUSION

Based on the findings of the present investigation, it can be inferred that the application of selected bee attractants at the 10% and 50% flowering stages substantially enhanced the floral visitation of *Apis florea* in niger. Among the evaluated treatments, 10% flower extract of *Madhuca longifolia*, 10% fruit extract of *Phoenix dactylifera* and 10% rose water were found to be the most effective attractants. These treatments consistently promoted comparatively greater visitation of *Apis florea* and were associated with higher seed yield than the other treatments. Therefore, the use of suitable bee attractants during critical flowering stages may serve as an effective approach for enhancing pollination activity and improving seed productivity in niger under field conditions.

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