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EFFECT OF INSECT ATTRACTANTS ON POLLINATION AND YIELD OF BROWN SARSON (*BRASSICA CAMPESTRIS* L.)

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ABSTRACT

The application of insect attractants significantly influenced pollinator activity and crop performance in brown sarson (*Brassica campestris* L.). A total of 16 floral visitor species belonging to six orders, viz., Hymenoptera, Diptera, Lepidoptera, Coleoptera, Hemiptera and Odonata, were observed during the study. Among the treatments, jaggery solution (10%) exhibited superior effectiveness by recording the highest abundance of *Lassioglossum marginatum* (23.3 ± 2.76), along with maximum visitation rate (2.33 ± 0.67) and percent visitation (3.28 ± 0.69), representing increases of 64.08%, 64.08% and 56.19%, respectively, over control. Enhanced pollinator activity under this treatment translated into significant improvements in yield and its components. The highest yield increment (54.5% over control) was obtained with jaggery solution (10%), whereas restricted (caged) conditions resulted in a yield decline of 4.18%. Substantial increases were also observed in test weight (73.59%), pod set (34.31%), number of seeds per pod (112.5%) and plant height (20.88%), coupled with a marked reduction in wrinkled seeds (88.95%). Biochemical analysis revealed a notable increase in vitamin C content (84.52%), while chlorophyll content showed a decrease (24%) compared to control. Other attractants such as sugar syrup (10%) and molasses (10%) were comparatively less effective. The findings demonstrate that jaggery solution (10%) serves as a highly efficient and economical strategy for improving pollination efficiency, yield, and quality in brown sarson.

***Keywords*:** Foraging behaviour, Abundance, Attractants, Jaggery, caging, brown Sarson.

Introduction

Brown sarson (*Brassica campestris* L.) is a vital rabi oilseed crop and an integral component of the edible oil economy, particularly in northern India and the Kashmir valley (Bhat *et al.*, 2018). Despite its agronomic adaptability and nutritional richness, the productivity of this crop remains considerably below its potential (Singh & Tomar, 2018). One of the most critical yet often overlooked constraints is inadequate and inefficient pollination (Abrol & Shankar, 2011). Although brown sarson produces abundant nectar and pollen and attracts a wide spectrum of insect visitors, successful fertilization largely depends on effective insect-mediated cross-pollination, which directly governs seed set, seed quality, and oil content(Devi, 2017). In recent decades, the reliability of natural pollination services has become increasingly uncertain (Hanley *et al.*, 2015). A global decline in both managed honeybee colonies and wild pollinator populations has been widely reported, driven by habitat loss, pesticide exposure, climate variability, and ecological disturbances (Li, 2024). This decline poses a serious threat to pollinator-dependent crops such as *Brassica*, where insufficient pollination results in poor pod formation, increased proportion of shrivelled seeds, and substantial yield losses (Subedi, 2019). Evidence suggests that even minor disruptions in pollinator activity can lead to significant reductions in both quantitative and qualitative crop parameters (Kevan & Phillips, 2001). While managed pollination using honeybee colonies is a known solution, it is often economically impractical and logistically challenging for small and marginal farmers, particularly under the Agro-climatic conditions of Jammu and Kashmir (Hanif *et al*., 2025). Moreover, reliance solely on natural pollinator populations is no longer sufficient to ensure optimal crop productivity. This creates a pressing need for simple, cost-effective, and field-adaptable strategies that can enhance pollinator activity without additional ecological burden. One promising yet underutilized approach is the application of insect attractants to manipulate pollinator behaviour (Zariman *et al*., 2022). Substances such as jaggery, sugar syrup, and molasses, which are rich in carbohydrates and volatile compounds, have shown potential in stimulating foraging activity and increasing insect visitation to crop flowers (Mahadik, 2019). By enhancing the attractiveness of floral resources, these attractants can improve pollination efficiency and subsequently influence yield attributes and biochemical composition of the crop. However, despite scattered reports on their effectiveness in different crops, systematic and region-specific studies evaluating their impact on brown sarson under temperate conditions are limited. Furthermore, most existing studies have primarily focused on yield improvement, with comparatively less attention given to the integrated effects of pollination on biochemical traits such as vitamin C and chlorophyll content, which are important indicators of nutritional quality. Understanding this relationship is crucial in the context of rising nutritional insecurity and the need to enhance both productivity and quality of oilseed crops. In this context, the present study was undertaken to explore the potential of indigenous insect attractants as an eco-friendly tool to enhance pollination efficiency in brown sarson. By addressing the dual challenge of declining pollinator services and suboptimal crop productivity, the study aims to contribute towards developing sustainable pollination management strategies for improving oilseed production in the Kashmir valley.

Materials and Methods

The present investigation was conducted during the rabi season of 2022–2023 at the Experimental Farm of the Division of Entomology, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K), Wadura, Sopore. The region falls under temperate climatic conditions of the Kashmir valley. The experimental crop, brown sarson (*Brassica campestris* L.) variety 'Shalimar Sarson-1', was raised following the recommended package of practices of SKUAST-K.

Area of study

The location of the study was 1610 metres above mean sea level, between 34 20' north latitude and 74 24' east longitude.

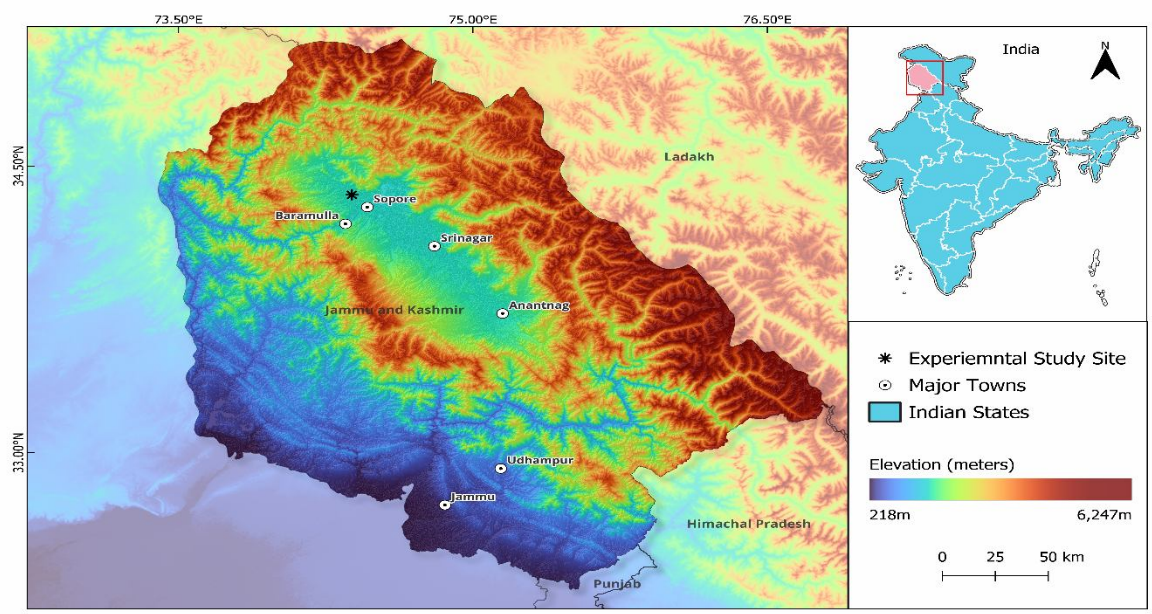

Fig. 1 : Location of the experiment

Experimental design and treatments

The experiment was laid out in a randomized block design comprising nine treatments, including a control and a pollinator exclusion treatment (caging). The treatments consisted of different indigenous insect attractants at two concentrations:

- T_0: Open pollination (control)
- T_1: Caged condition (pollinator exclusion)
- T_2: Jaggery (5%)
- T_3: Sugar solution (5%)
- T_4: Molasses (5%)
- T_5: Jaggery (10%)
- T_6: Sugar solution (10%)
- T_7: Molasses (10%)
- T_8: Water spray

The crop was sown during the third week of September in plots maintained at a spacing of 30 × 10 cm. Each treatment was replicated thrice, and observations were recorded from randomly selected and tagged plants in each plot.

Application of attractants

The attractant solutions were prepared freshly and applied as foliar sprays using a hand sprayer. Two applications were made during the flowering period, at 20% and 50% flowering stages, under uniform climatic conditions.

Recording of pollinator activity

Pollinator diversity: Insect pollinators visiting the crop were collected using insect nets and observed visually with the aid of a magnifying lens. Specimens were preserved, pinned, and identified in the laboratory of the Division of Entomology.

Abundance: Number of flower visits per species in 10 minutes (8:00–11:00 h), recorded visually and confirmed by insect collection and identification.

Visitation rate: Number of flowers visited per unit time, calculated as:

$$\frac{\text{Total Number of visits}}{\text{Flowering inflorescence of one meter square length}(m^2)} \times 100$$

Percent visitation

The relative visitation of each pollinator species was calculated as percentage contribution to total visits.

Fig. 2 : Pollinators/visitors collected from brown sarson (*Brassica campestris* L.)

Foraging behaviour

Time spent per flower measured using a stopwatch on 10 randomly selected flowers during peak flowering

Statistical analysis

The data obtained from various observations were subjected to appropriate statistical analysis using standard analytical methods (R software and OP STAT). Treatment means were compared to determine the significance of differences among treatments.

Result

The present investigation recorded a total of 16 insect species belonging to six orders, viz., Hymenoptera, Diptera, Lepidoptera, Coleoptera, Hemiptera and Odonata visiting brown sarson flowers. Among these, Hymenopteran species, particularly *Apis cerana indica*, *Apis mellifera*, *Bombus trifaciatus* and *Lassioglossum* spp., were the dominant pollinators. Although a diverse assemblage of pollinators was observed, these four species contributed the majority of floral visits and played a key role in pollination activity. The higher representation of Hymenoptera indicates their primary role in pollination, which may be attributed to their efficient foraging behaviour, floral constancy, and ability to exploit nectar and pollen resources effectively. The results given in table 1 depicts among the major pollinators, *Lassioglossum marginatum* exhibited significantly higher abundance under jaggery solution (10%) at both 20 per cent (21.2 ± 2.25) and 50 per cent flowering stages (23.3 ± 2.76) as compared to control (12.2 ± 1.02 and 14.2 ± 1.06, respectively). A similar trend was observed in percent visitation rate, where jaggery (10%) recorded the highest values (3.49 ± 0.76 and 3.28 ± 0.69), followed by molasses (10%) and sugar syrup (10%). The insect visitation rate was also maximum under jaggery (10%) (2.12 ± 0.55 and 2.33 ± 0.67), indicating enhanced foraging activity, whereas water and control treatments recorded the lowest values. Likewise, *Lassioglossum* *himalayense* showed significantly higher abundance under jaggery (10%) (20.2 ± 2.25 and 22.4 ± 2.43) compared to control (11.4 ± 1.03 and 12.6 ± 1.34), with percent visitation rate also being highest under jaggery (10%) (3.20 ± 0.98 and 3.33 ± 0.99), followed by molasses and sugar syrup treatments. The insect visitation rate in this species ranged from 1.14 ± 0.27 to 2.24 ± 0.92, with maximum values recorded under jaggery treatment at both flowering stages. In the case of *Apis cerana indica*, the abundance was significantly enhanced by attractant application, with jaggery (10%) recording the highest values (16.4 ± 1.76 and 17.4 ± 1.57), followed by molasses and sugar syrup treatments, while control and water treatments showed comparatively lower values. The percent visitation rate was also maximum under jaggery (10%) (2.41 ± 0.91 and 3.11 ± 0.94), along with higher insect visitation rate (1.64 ± 0.79 and 1.74 ± 0.89). However, in *Apis mellifera*, a slightly different response was observed, wherein molasses (10%) and sugar syrup (10%) recorded higher abundance (12.2 ± 1.26 and 15.5 ± 1.65; 11.8 ± 1.16 and 14.9 ± 1.53, respectively) compared to control. The percent visitation rate was highest under molasses (10%) (2.04 ± 0.93 and 1.66 ± 0.76), followed by sugar syrup treatment, while insect visitation rate was also higher under molasses (10%) (1.22 ± 0.77 and 1.55 ± 0.65) compared to other treatments.

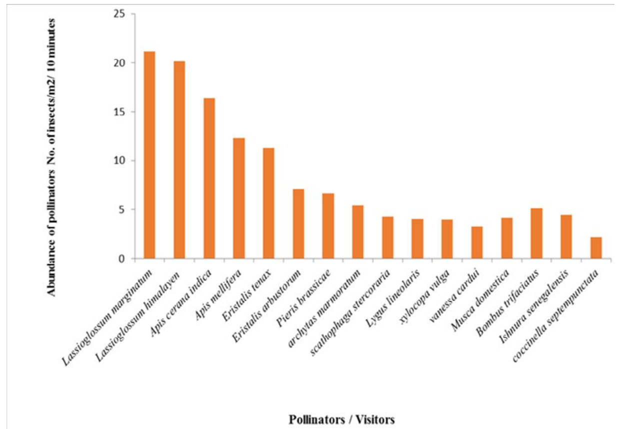

Fig. 3 : Abundance of pollinators/visitors on brown sarson at 20 per cent flowering during 2022-2023

Table 1 : Effect of insect attractants on foraging behaviour of *major sp.* on brown sarson (*Brassica campestris* L.)

Treatments	Abundance		Per cent insect visitation rate		Insect visitation rate	
			Lassioglossum marginatum			
	20 per cent Flowering	50 per cent Flowering	20 per cent Flowering	50 per cent Flowering	20 per cent Flowering	50 per cent Flowering
Control	12.2 ± 1.02a	14.2 ± 1.06a	1.8 ± 0.07a	2.10 ± 0.19a	1.22 ± 0.07a	1.42 ± 0.09a
Jaggery @10%	**21.2** ± 2.25^{c}	**23.3** ± 2.76^{b}	**3.49** ± 0.76^{c}	**3.28** ± 0.69^{c}	**2.12** ± 0.55^{c}	**2.33** ± 0.67^{c}
Sugar syrup @10%	18.2 ± 1.91^{b}	19.3 ± 2.17^{b}	3.13 ± 0.42^{c}	2.47 ± 0.45^{a}	1.82 ± 0.38^{b}	1.93 ± 0.51^{b}
Molasses @10%	19.6 ± 2.11^{c}	20.2 ± 2.45^{b}	3.27 ± 0.54^{c}	2.85 ± 0.55^{b}	1.96 ± 0.41^{c}	2.02 ± 0.60^{b}
Water	13.5 ± 1.11^{a}	14.5 ± 1.20^{a}	2.20 ± 0.09^{a}	2.23 ± 0.10^{a}	1.35 ± 0.12^{a}	1.45 ± 0.13^{a}
			Lassioglossum himalanses			
Control	11.4 ± 1.03^{a}	12.6 ± 1.34^{a}	1.33 ± 0.37^{a}	1.83 ± 0.47^{a}	1.14 ± 0.27^{a}	1.26 ± 0.30^{a}
Jaggery @10%	**20.2** ± 2.25^{d}	**22.4** ± 2.43^{d}	**3.20** ± 0.98^{c}	**3.33** ± 0.99^{c}	**2.02** ± 0.87^{b}	**2.24** ± 0.92^{d}
Sugar syrup @10%	17.3 ± 2.09^{c}	17.3 ± 1.97^{b}	2.60 ± 0.64^{b}	2.33 ± 0.78^{b}	1.73 ± 0.67^{b}	1.73 ± 0.76^{c}
Molasses @10%	18.2 ± 2.20^{c}	19.1 ± 2.23^{c}	3.11 ± 0.82^{c}	2.50 ± 0.92^{b}	1.82 ± 0.77^{b}	1.91 ± 0.89^{c}
Water	13.0 ± 1.09^{a}	13.5 ± 1.47^{a}	1.55 ± 0.39^{a}	1.98 ± 0.56^{a}	1.30 ± 0.35^{a}	1.35 ± 0.37^{a}
			Apis cerana indica			
Control	9.4 ± 1.01^{a}	10.3 ± 1.08^{a}	1.01 ± 0.04^{a}	1.54 ± 0.42^{a}	0.94 ± 0.15^{a}	1.13 ± 0.07^{a}
Jaggery @10%	**16.4** ± 1.76^{c}	**17.4** ± 1.57^{b}	**2.41** ± 0.91^{d}	**3.11** ± 0.94^{d}	**1.64** ± 0.79^{c}	**1.74** ± 0.89^{b}
Sugar syrup @10%	13.5 ± 1.57^{b}	16.5 ± 1.39^{b}	1.86 ± 0.76^{c}	2.34 ± 0.74^{b}	1.35 ± 0.62^{b}	1.65 ± 0.66^{b}
Molasses @10%	15.3 ± 1.69^{b}	16.9 ± 1.43^{b}	1.91 ± 0.87^{c}	2.71 ± 0.86^{c}	1.53 ± 0.65^{b}	1.69 ± 0.76^{b}
Water	10.7 ± 1.17^{a}	11.5 ± 1.16^{a}	1.11 ± 0.14^{a}	1.98 ± 0.52^{b}	1.07 ± 0.25^{a}	1.15 ± 0.12^{a}
			Apis mellifera			
Control	8.9 ± 0.85^{a}	10.3 ± 1.08^{a}	0.98 ± 0.13^{a}	0.88 ± 0.16^{a}	0.89 ± 0.08^{a}	1.03 ± 0.04^{a}
Jaggery @10%	8.9 ± 0.85^{a}	10.3 ± 1.08^{a}	0.98 ± 0.13^{a}	0.88 ± 0.16^{a}	0.89 ± 0.08^{a}	1.03 ± 0.04^{a}
Sugar syrup @10%	11.8 ± 1.16^{b}	14.9 ± 1.53^{b}	1.59 ± 0.88^{b}	1.54 ± 0.64^{b}	1.18 ± 0.65^{b}	1.49 ± 0.45^{b}
Molasses @10%	12.2 ± 1.26^{b}	15.5 ± 1.65^{b}	2.04 ± 0.93^{c}	1.66 ± 0.76^{b}	1.22 ± 0.77^{b}	1.55 ± 0.65^{b}
Water	9.71 ± 0.91^{a}	10.9 ± 1.16^{a}	1.15 ± 0.24^{a}	0.94 ± 0.23^{a}	0.97 ± 0.17^{a}	1.09 ± 0.15^{a}

Discussion

The present findings clearly demonstrate that the application of insect attractants significantly influenced the abundance and foraging behaviour of major pollinators on brown sarson. Among the attractants evaluated, jaggery solution (10%) proved to be the most effective in enhancing pollinator activity. The higher abundance and visitation rates observed under jaggery treatment may be attributed to its rich carbohydrate content and the presence of volatile compounds that mimic natural floral rewards, thereby acting as strong olfactory cues for pollinators. Such cues are known to stimulate foraging behaviour and improve floral constancy, ultimately enhancing pollination efficiency (Sharma *et al*., 2023). The increased pollinator activity at 50 per cent flowering stage compared to 20 per cent flowering stage further indicates that peak bloom, coupled with attractant application, provides optimal conditions for insect visitation. This may be due to greater availability of floral resources such as nectar and pollen during this stage, which synergistically enhances the effectiveness of attractants. Similar observations have been reported in other crops, where pollinator visitation increases with floral density and resource availability (Kumar *et al*., 2023). Interestingly, *Apis mellifera* showed a comparatively different response, with higher activity recorded under molasses (10%) and sugar syrup (10%) treatments. This variation among species may be due to differences in foraging preferences, sensory perception, and adaptability to different sugar compositions and volatile profiles of attractants. Species-specific responses of pollinators to floral cues and artificial attractants have also been documented by Sagili *et al.* (2015); Su *et al.*, 2022 indicating that attractant efficiency may vary depending on pollinator behaviour and ecological conditions. The significantly lower values recorded under control and water treatments, and the absence of pollinator activity under caged conditions, clearly emphasize the dependence of brown sarson on insect-mediated pollination. Reduced visitation under these treatments may lead to inefficient pollen transfer and poor fertilization, ultimately affecting seed set and yield. In contrast, enhanced visitation rate and abundance under attractant treatments indicate improved pollen transfer dynamics, which are directly associated with better reproductive success. Similar findings have been reported in cucumber by Hanif *et al*., 2025. The present results are in agreement with earlier studies reporting increased pollinator visitation and foraging efficiency with the application of carbohydrate-based attractants such as jaggery, molasses and sugar solutions. These attractants have been shown to enhance bee activity and improve pollination services in crops like cucumber, sunflower and bitter gourd (Manchare *et al*., 2019; Dorjay *et al*., 2022; Deepa & Nayaka, 2021). Furthermore, the observed improvement in foraging behaviour supports the concept that manipulation of pollinator behaviour through external inputs can serve as an effective strategy to mitigate the effects of declining pollinator populations (Nicholls & Altieri, 2013).

Conclusion

Insect attractants markedly enhance pollinator abundance and foraging activity in brown sarson, with jaggery solution (10%) emerging as the most effective treatment. The strong response of dominant pollinators, particularly *Lassioglossum* spp. and *Apis cerana indica*, underscores their key role in optimizing pollination efficiency. Adoption of such low-cost, eco-friendly attractants offers a practical approach to strengthen pollination services and improve crop productivity under temperate conditions.

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