

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(5): 319-324
www.biochemjournal.com
Received: 28-02-2026
Accepted: 30-03-2026

Kiran Naik
Department of Entomology,
College of Agriculture,
Raichur, Karnataka, India

Dr. Basavaraj K
Assistant Professor,
Department of Entomology,
College of Agriculture,
Gangavathi, Karnataka, India

Sanganna M Sajjanar
Department of Entomology,
MARS, Raichur, Karnataka,
India

Kiran Kumar R
Department of Entomology,
College of Agriculture,
Gangavathi, Karnataka, India

Bharathi S
Department of Genetics and
Plant Breeding, MARS,
Raichur, Karnataka, India

Saleemali Kannihalli
Department of Entomology,
College of Agriculture,
Gangavathi, Karnataka, India

Corresponding Author:
Dr. Basavaraj K
Assistant Professor,
Department of Entomology,
College of Agriculture,
Gangavathi, Karnataka, India

Improving castor yield through enhanced pollinator activity using bee attractants

Kiran Naik, Basavaraj K, Sanganna M Sajjanar, Kiran Kumar R, Bharathi S and Saleemali Kannihalli

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i5Sd.8371>

Abstract

Castor (*Ricinus communis* L.) is an important industrial oilseed crop, and pollination plays a crucial role in enhancing its yield. Although wind is the primary pollinating agent, insect pollinators, particularly bees, significantly improve fruit set and productivity. However, information on the use of bee attractants to enhance pollination efficiency in castor is limited. The present study was conducted using hybrid ICH-66 in a randomized block design with seven treatments and three replications. The treatments included sugar solution (5%), jaggery solution (10%), basil oil (0.5%), lemongrass oil (0.5%), mint oil (0.5%), profuse paste, and an untreated control. Bee attractants were applied during the flowering period, and observations were recorded on bee visitation and yield parameters such as number of capsules per plant, capsule setting (%), test weight (g), oil content (%), and seed yield (q/ha). Application of bee attractants significantly increased pollinator activity compared to the control. The highest bee visitation (2.80-3.20 bees/spike/5 min) was recorded in profuse-treated plots, followed by basil oil (2.73-3.08 bees/spike/5 min). The effect of attractants was most pronounced between the third and fifth day after spraying. Profuse treatment resulted in the highest capsule setting (83.72%), number of capsules per plant (94.32), test weight (35.48 g), and seed yield (26.47 q/ha), showing a 56.71% increase over control. Oil content was not significantly influenced by the treatments. The study indicates that the application of profuse during flowering enhances pollination efficiency and yield in castor.

Keywords: Bee attractants, castor, pollinator activity, seed yield, visitation

1. Introduction

Castor (*Ricinus communis* L.), commonly known as castor bean or castor oil plant, is an important non-edible oilseed crop belonging to the family Euphorbiaceae. It holds considerable economic and industrial significance and ranks fifth among the major annual oilseed crops. The crop is believed to have originated in Ethiopia, which is considered its centre of origin due to the presence of high genetic diversity (Anjani, 2012) [1]. At present, castor is cultivated in more than 30 countries across tropical and subtropical regions, with India emerging as the leading producer, contributing over 60 percent of the global production, followed by countries such as China, Brazil, and Thailand (Melo *et al.*, 2008) [14]. The economic importance of castor lies in its seeds, which contain 48 to 55 percent oil rich in ricinoleic acid, a unique fatty acid responsible for its exceptional physicochemical properties. This oil has wide-ranging industrial applications, including in the manufacture of lubricants, cosmetics, paints, pharmaceuticals, nylon, and explosives (Copley *et al.*, 2005) [5]. In India, Gujarat is the major castor-producing state, while in Karnataka, the crop is predominantly cultivated in districts such as Chitradurga, Tumkur, Raichur, and Ballari (Anon., 2024a) [2]. In recent years, castor has also gained prominence as a potential renewable resource for biodiesel production, further enhancing its economic value (Sailaja *et al.*, 2008) [18].

From a botanical perspective, castor is a monoecious plant bearing distinct male and female flowers on the same inflorescence. Although it is primarily considered a wind-pollinated crop, the role of insect pollinators, particularly honey bees, in enhancing pollination efficiency has been increasingly recognized. Insect-mediated pollination, including geitonogamy, facilitates effective pollen transfer, leading to improved fruit set, seed development, and ultimately higher yield (Rizzardo *et al.*, 2012; Douka and Fohouo, 2014) [17, 6].

The significance of pollinators extends beyond individual crops, as global estimates suggest that pollination services contribute approximately USD 577 billion annually, with nearly 87 percent of crop species benefiting from animal-mediated pollination (Vinod and Sattagi, 2016) [20].

Despite the recognized importance of pollinators in enhancing crop productivity, there is limited information available on strategies to actively attract and manage pollinators in castor cultivation. The use of bee attractants represents a promising approach to enhance pollinator visitation and improve pollination efficiency under field conditions. However, systematic studies evaluating the effectiveness of different attractants on pollinator activity and yield parameters in castor are scarce.

Therefore, the present investigation was undertaken to assess the influence of various bee attractants on pollinator activity and yield of castor under field conditions, with the objective of identifying effective attractants that can enhance pollination and productivity.

2. Materials and Methods

The present investigation was carried out at the College of Agriculture, Gangavathi, University of Agricultural Sciences, Raichur, Karnataka, India, during the flowering period of castor (*Ricinus communis* L.) (kharif 2024). The experiment was conducted using the hybrid ICH-66 under field conditions. The study was laid out in a randomized block design (RBD) comprising seven treatments with three replications. Each experimental plot measured 6 m × 5 m, with a spacing of 90 cm between rows and 60 cm between plants, following recommended agronomic practices (Anon., 2024b) [3].

The treatments consisted of sugar solution (5%), jaggery solution (10%), basil oil (0.5%), lemongrass oil (0.5%), mint oil (0.5%), profuse paste (applied as three spots per plant), and an untreated control. Bee attractants were applied during the flowering stage using a standard knapsack sprayer during morning hours to coincide with peak pollinator activity. A second spray was applied one week after the first application.

Pollinator activity was assessed by recording the abundance of bee visitors before and after the application of treatments. Observations were made at 1, 3, 5, and 7 days after spraying (DAS), and the number of bees visiting per spike was recorded over a fixed observation period. Observations on yield and yield-attributing parameters were recorded at harvest. These included number of capsules per plant, capsule setting (%), test weight (100-seed weight in g), oil content (%), and seed yield (q ha⁻¹). Capsule setting was calculated by counting the total number of flowers and the number of capsules formed on ten randomly selected spikes per treatment and expressed as a percentage using the following formula:

Capsule setting (%) = (Number of capsules formed/Total number of flowers) × 100

Test weight was determined by weighing 100 well-filled, air-dried seeds from each treatment using a precision electronic balance and expressed in grams. Oil content was estimated using a Nuclear Magnetic Resonance (NMR) analyzer. Seed yield from each plot was recorded and extrapolated to a hectare basis, expressed in quintals per hectare (q ha⁻¹).

2.1 Statistical analysis

The experimental data were subjected to analysis of variance (ANOVA) appropriate for a randomized block design, as described by Gomez and Gomez (1984) [8]. Treatment means were compared using the critical difference (CD) test at the 5 percent level of significance (p = 0.05). All statistical analyses were performed using SPSS software (version 26.0; IBM Corp., Armonk, NY, USA).

3. Results and Discussion

3.1 Bee visitation at first and second spray

The results on bee visitation patterns revealed that the application of bee attractants significantly influenced the number of bee visits on castor spikes. Day before spraying (DBS), there were no significant differences among treatments, indicating uniform bee activity across plots. However, on the first day after the first spray (1 DAS), bee visitation was markedly higher in the profuse paste-applied plots (2.80 bees/spike/5 min) and basil oil (0.5%) sprayed plots (2.73 bees/spike/5 min), followed by lemongrass oil (1.88), mint oil (1.33), jaggery solution (10%) (1.27) and sugar solution (5%) (1.07). The control plots recorded the lowest visitation (0.68 bees/spike/5 min). The peak bee activity was observed between the third and fifth day after spraying, particularly in the profuse (3.00-3.20 bees/spike/5 min) and basil oil treatments (1.93-1.73 bees/spike/5 min), with a gradual decline thereafter as the volatile compounds dissipated.

A similar trend was noted after the second spray, where bee visitation again peaked in profuse (2.88 bees/spike/5 min) and basil oil (2.73 bees/spike/5 min) plots on the first day after spraying, followed by lemongrass (1.80), mint (1.40), jaggery (1.33) and sugar solution (1.00) recorded moderate bee activity, while the control showed the minimal visitation (0.73 bees/spike/5 min). The maximum bee visitation occurred between the third and fifth day after spraying, mirroring the pattern of the first spray as shown in Table.1 and Fig. 1.

These results suggest that both essential oil-based attractants (basil and lemongrass) and food-based attractants (sugar and jaggery solutions) stimulate bee foraging activity, with profuse and basil oil treatments showing the highest effectiveness. The results of the present study are in line with the Jayaramappa and Bhargava (2015) [9] who studied the relative abundance based on honey bee visitation (*A. cerana*, *A. dorsata* and *A. florea*) to sunflower and results showed that flowers on the first day after the first spray (1DAFS) was greatest for the Fruit Boost plots treated with 0.75 ml/l and the Bee-Q plots treated with 12.5 g/l (5.00 bees/10 flowers/5 min). Kulkarni *et al.* (2017) [11] studied the effects of different indigenous bee attractants in onion and found that jaggery and sugar solution (10%) attracted maximum number of *A. dorsata*. Patel and Sattagi (2007) [16] reported that treatment of sugar and jaggery solution attracted more honey bees up to three days of first and second sprays, whereas their activities decreased after five days of spray.

3.2 Impact of bee attractants on yield of castor

The application of bee attractants significantly influenced various yield-contributing parameters of castor. Treatments differed markedly in their impact on capsule formation, capsule setting, seed weight and overall yield performance. The results clearly indicate that the use of attractants

enhanced pollinator activity, leading to improved reproductive success and yield attributes of the crop as shown in Table. 2 and Fig. 2.

3.2.1 Number of Capsules per Plant

Significant differences were observed among treatments for the number of capsules per plant. The profuse-applied plots recorded the highest number of capsules (94.32), followed by basil oil (83.76) and lemongrass oil (72.05). While the control showed the lowest value (33.89). These findings highlight the positive role of bee attractants in enhancing pollinator activity, which directly contributes to higher capsule formation. Similar trends were reported by Viraktamath and Patil (1999) ^[21], who observed increased capsule numbers in crops treated with bee attractants such as Citral and Bee-Q compared to untreated controls.

3.2.2 Capsule Setting (%)

Capsule setting was highest in profuse (83.72%), followed by basil oil (71.30%), lemongrass oil (59.02%), and mint oil (54.13%), while the control recorded the lowest value (36.85%). The percentage increase over control was maximum in profuse (78.16%), indicating its superior ability to attract pollinators and facilitate effective pollen transfer. These results align with Pashte *et al.* (2015) ^[15] and Chandran *et al.* (2012) ^[4], who reported increased capsule setting in sesame using essential oil-based attractants such as Citral and Fruit Boost. The improvement in capsule set is attributed to higher flower visitation frequency and enhanced pollen deposition by foraging bees.

3.2.3 Test Weight (g)

The 100-seed weight was significantly higher in profuse

(35.48 g), followed by basil oil (34.33 g) and lemongrass oil (33.48 g). While the control recorded the lowest (29.20 g). The increased test weight under attractant treatments suggests improved fertilization and seed filling due to effective pollination. Similar observations were reported by Kumar *et al.* (2021) ^[12] in sunflower and Kaur *et al.* (2023) ^[10] in sesame, where jaggery and sugar solutions significantly increased seed weight.

3.2.4 Oil Content (%)

No significant variation in oil content was observed among treatments, although slight increases were noted in bee-attractant-applied plots. This indicates that while attractants enhance pollination and yield-related traits, oil accumulation is primarily influenced by genetic and environmental factors. Sivaram *et al.* (2013) ^[19] reported comparable findings in *Guizotia abyssinica*, where bee attractants improved yield but did not affect oil percentage.

3.2.5 Seed Yield (q/ha)

Seed yield varied significantly among treatments. The profuse-applied plots recorded the highest yield (26.47 q/ha), followed by basil oil (24.08 q/ha), lemongrass oil (23.28 q/ha), and mint oil (22.75 q/ha). Whereas control showed the lowest (16.89 q/ha). The percentage increase over control was maximum in profuse (56.71%), demonstrating its effectiveness in improving pollination efficiency and overall productivity. These results are in agreement with Kumari *et al.* (2017) ^[13] and Ganapathi (2005) ^[7], who reported substantial yield increases in crops treated with Bee-Q and Fruit Boost attractants.

Table 1: Influence of bee attractants on visitation of honey bees

Sl. No.	Treatments	No. of bees/spike/5 min											
		First spray						Second spray					
		DBS	1 DAS	3 DAS	5 DAS	7 DAS	Mean	DBS	1 DAS	3 DAS	5 DAS	7 DAS	Mean
1	Sugar solution 5%	0.60 (1.26)	1.07 (1.44) ^{cd}	1.13 (1.46) ^{cd}	0.88 (1.36) ^{cd}	0.73 (1.31) ^{cd}	0.88	0.53 (1.23)	1.00 (1.41) ^c	1.27 (1.50) ^{bc}	0.80 (1.34) ^d	0.68 (1.29) ^d	0.85
2	Jaggery solution 10%	0.53 (1.24)	1.27 (1.50) ^{bc}	1.33 (1.53) ^{bc}	1.20 (1.48) ^c	1.13 (1.46) ^{bc}	1.09	0.73 (1.32)	1.33 (1.52) ^{bc}	1.40 (1.54) ^b	1.33 (1.53) ^{bc}	1.20 (1.48) ^c	1.19
3	Basil oil 0.5%	0.66 (1.29)	2.73 (1.93) ^a	2.73 (1.93) ^a	2.93 (1.98) ^a	2.60 (1.90) ^a	2.33	0.66 (1.29)	2.73 (1.93) ^a	3.06 (2.02) ^a	3.08 (2.02) ^a	2.73 (1.93) ^a	2.45
4	Lemongrass oil 0.5%	0.73 (1.31)	1.88 (1.69) ^b	1.93 (1.71) ^b	1.73 (1.65) ^b	1.68 (1.63) ^b	1.59	0.60 (1.26)	1.80 (1.67) ^b	1.88 (1.69) ^b	1.73 (1.65) ^b	1.73 (1.65) ^b	1.54
5	Mint oil 0.5%	0.46 (1.21)	1.33 (1.53) ^{bc}	1.48 (1.57) ^{bc}	1.28 (1.51) ^{bc}	1.20 (1.48) ^{bc}	1.15	0.80 (1.34)	1.40 (1.54) ^{bc}	1.40 (1.54) ^b	1.33 (1.53) ^{bc}	1.26 (1.50) ^c	1.23
6	Profuse	0.60 (1.26)	2.80 (1.95) ^a	3.00 (2.00) ^a	3.20 (2.05) ^a	2.66 (1.91) ^a	2.45	0.60 (1.26)	2.88 (1.97) ^a	3.06 (2.02) ^a	3.20 (2.05) ^a	2.73 (1.93) ^a	2.49
7	Control	0.68 (1.29)	0.68 (1.29) ^d	0.73 (1.31) ^d	0.60 (1.26) ^d	0.66 (1.29) ^d	0.67	0.73 (1.31)	0.73 (1.32) ^c	0.67 (1.29) ^c	0.60 (1.26) ^d	0.68 (1.29) ^d	0.68
	S.Em (±)	0.05	0.06	0.07	0.06	0.06	-	0.05	0.06	0.07	0.09	0.04	-
	C.D @ 5%	NS	0.19	0.21	0.19	0.18	-	NS	0.18	0.22	0.28	0.12	-
	C.V (%)	7.61	8.49	7.59	7.29	7.45	-	7.01	7.91	7.83	9.75	7.43	-

Note: DBS: Day before spray, DAS: Days after spray

Figures in parenthesis are square root transformed values;

Values within a column followed by same letters are not-significant at p = 0.05 by DMRT

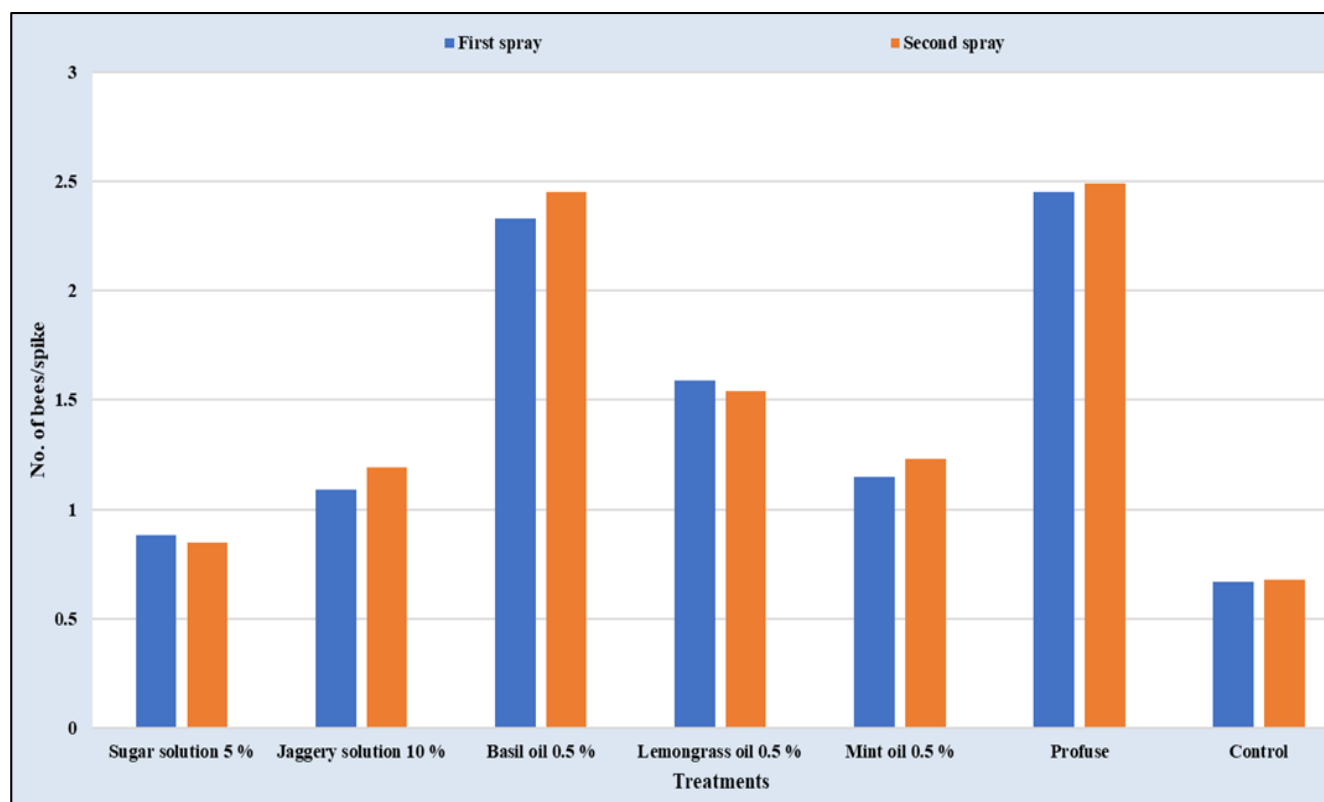
Table 2: Effect of different bee attractants on the yield parameters of castor

Sl. No.	Treatments	No. of capsules/plant	Capsule setting (%)	Percent increase in capsule setting over untreated control	Test weight (g)	Oil content (%)	Seed yield (q/ha)	Percent increase in seed yield over untreated control
1	Sugar solution 5%	44.46 (6.74) ^{de*}	47.74 (43.70) ^{eh}	17.24	30.50 ^{cd}	41.44 (40.07) [#]	19.31 (4.02) ^{d*}	14.32
2	Jaggery solution 10%	52.10 (7.29) ^{cd}	53.85 (47.21) ^{cd}	26.60	31.64 ^{bc}	41.50 (40.11)	20.68 (4.61) ^c	22.43
3	Basil oil 0.5%	83.76 (9.21) ^{ab}	71.30 (57.65) ^b	54.63	34.33 ^{ab}	39.08 (38.65)	24.08 (6.34) ^b	42.56
4	Lemongrass oil 0.5%	72.05 (8.55) ^b	59.02 (50.23) ^c	34.76	33.48 ^{ab}	40.42 (39.48)	23.28 (6.20) ^b	37.83
5	Mint oil 0.5%	60.74 (7.86) ^{bc}	54.13 (47.37) ^{cd}	27.06	32.18 ^{bc}	41.02 (39.82)	22.75 (5.80) ^b	34.69
6	Profuse	94.32 (9.76) ^a	83.72 (66.42) ^a	78.16	35.48 ^a	38.48 (38.34)	26.47 (6.89) ^a	56.71
7	Untreated control	33.89 (5.76) ^f	36.85 (37.28) ^f	-	29.20 ^e	39.34 (38.84)	16.89 (3.38) ^e	-
S.Em ($\pm$)		1.01	2.12	-	0.32	1.01	0.15	-
C.D @ 5%		NS	6.36	-	0.98	NS	0.53	-
C.V (%)		4.34	7.15	-	9.63	4.34	7.05	-

Note: *Figures in parenthesis are square root transformed values;

#Figures in parenthesis are arc sine transformed values

Values within a column followed by same letters are not-significant at $p = 0.05$ by DMRT

**Fig 1:** Influence of bee attractants on visitation of honey bees after first and second spray

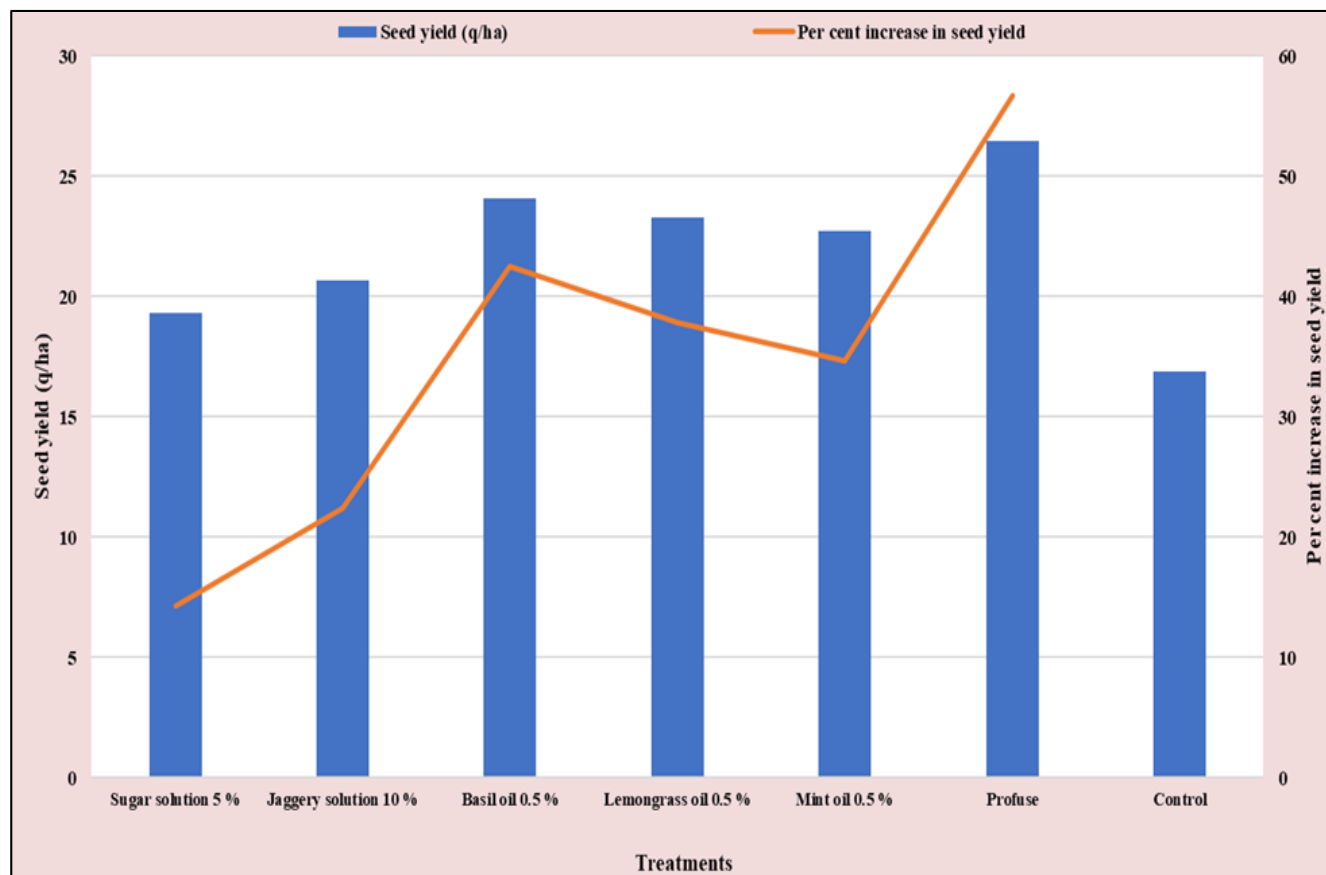


Fig 2: Impact of different bee attractants on the yield parameters of castor

4. Conclusion

The present study demonstrated that the application of bee attractants significantly enhances pollinator activity and yield parameters in castor. Among the treatments evaluated, profuse paste proved to be the most effective, followed by basil oil (0.5%), in increasing bee visitation, capsule setting, number of capsules per plant, test weight, and seed yield. The increased pollinator activity, particularly during the third to fifth day after spraying, played a crucial role in improving reproductive success and overall productivity of the crop. Although oil content remained unaffected by the treatments, the substantial improvement in yield highlights the importance of pollinator management in castor cultivation. The findings suggest that the use of bee attractants, especially profuse, can be an effective and practical strategy to enhance pollination efficiency and yield under field conditions. Further studies may focus on standardizing application schedules and evaluating long-term economic benefits of attractant use in different agro-climatic regions.

5. Acknowledgement

The authors are grateful to the College of Agriculture, Gangavathi, University of Agricultural Sciences, Raichur, Karnataka, India, for providing the experimental field, laboratory facilities and technical support necessary to conduct this study.

References

1. Anjani K. Castor genetic resources: a primary gene pool for exploitation. *Ind Crops Prod.* 2012;35(1):1-14.
2. Anonymous. Area, production and productivity. Directorate of Economics and Statistics; 2024a.
3. Anonymous. Package of Practice of Agricultural Crops. Raichur: University of Agricultural Sciences; 2024b.
4. Chandran N, Viraktamath S, Palakshappa MG. Influence of indigenous bee attractants in enhancing pollination and yield of sesame (*Sesamum indicum* L.) [MSc thesis]. Dharwad (India): University of Agricultural Sciences; 2012.
5. Copley MS, Bland HA, Rose P, Horton M, Evershed RP. Gas chromatographic, mass spectrometric and stable carbon isotopic investigations of organic residues of plant oils and animal fats employed as illuminants in archaeological lamps. *Analyst.* 2005;130(6):860-871.
6. Douka C, Fohouo FNT. Foraging and pollination activity of *Musca domestica* on flowers of *Ricinus communis* L. (Euphorbiaceae) at Moroua, Cameroon. *J Biodivers Environ Sci.* 2014;4(3):63-76.
7. Ganapathi K. Impact of bee attractants on bee activity and yield parameters of Bt cotton [PhD thesis]. Bangalore (India): University of Agricultural Sciences, GKVK; 2005.
8. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. 2nd ed. New York: John Wiley and Sons; 1984.
9. Jayaramappa KV, Bhargava HR. Enhancement of crop productivity in sunflower (*Helianthus annuus* L.) by the influence of honey bee attractants. *World Appl Sci J.* 2015;33(4):673-678.
10. Kaur J, Kaur G, Bajaj K, Singh A, Singh R, Kaur N. Effect of indigenous bee attractants on bee visitation and seed production of sesame (*Sesamum indicum* L.). *Environ Ecol.* 2023;41(4D):3054-3059.
11. Kulkarni SR, Gurve SS, Chormule AJ. Effect of different indigenous bee attractants in onion (*Allium cepa* L.) crop. *Ann Plant Prot Sci.* 2017;25(1):78-82.

12. Kumar R, Patil SR, Viraktamath S. Effect of bee attractants on seed yield and quality parameters of sesame (*Sesamum indicum* L.). J Entomol Zool Stud. 2021;9(1):137-141.
13. Kumari S, Rana K, Sharma HK, Thakur AK. Effect of bee attractants on yield and quality of onion seed. J Hill Agric. 2017;8(1):46-49.
14. Melo WC, Santos AS, Santa LMM, Pereira N. Acid and enzymatic hydrolysis of the residue from castor bean (*Ricinus communis* L.) oil extraction for ethanol production: detoxification and biodiesel process integration. J Braz Chem Soc. 2008;19:418-425.
15. Pashte VV, Shylesha AN, Badge AS. Effect of honey bee pollination, bee attractants and scents on yield of sesamum. Int J Ecol Environ Sci. 2015;41(2):87-93.
16. Patel MC, Sattagi HN. Effect of different attractants on attracting the bees to cucumber (*Cucumis sativa* L.) crop. Karnataka J Agric Sci. 2007;20(4):761-763.
17. Rizzardo RA, Milfont MO, Silva E, Freitas BM. *Apis mellifera* pollination improves agronomic productivity of anemophilous castor bean (*Ricinus communis* L.). An Acad Bras Cienc. 2012;84(4):1137-1145.
18. Sailaja M, Tarakeswari M, Sujatha M. Stable genetic transformation of castor (*Ricinus communis* L.) via particle gun-mediated gene transfer using embryo axes from mature seeds. Plant Cell Rep. 2008;27:1509-1519.
19. Sivaram V, Jayaramappa KV, Menon A, Ceballos RM. Use of bee-attractants in increasing crop productivity in niger (*Guizotia abyssinica* L.). Braz Arch Biol Technol. 2013;56(3):365-370.
20. Vinod M, Sattagi HN. Bee pollination under organic and conventional farming systems: a review. J Exp Zool. 2016;19(2):643-652.
21. Viraktamath S, Patil RK. Preliminary studies on the influence of bee attractants on bee visitation and yield parameters of sesame (*Sesamum indicum* L.). Indian Bee J. 1999;61(1-4):55-58.