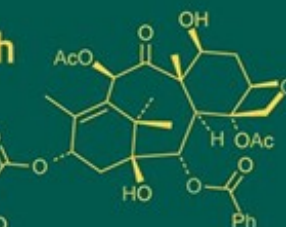
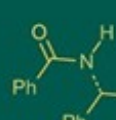


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Evaluation of poison baits and development of a containment trap for the management of terrestrial snails

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ABSTRACT

A field investigation was conducted during the Kharif 2025 season in a naturally infested soybean plot at Sadoli Khalsa, Kolhapur, Maharashtra, to evaluate the efficacy of different poison baits and develop a custom physical trap for the management of terrestrial snails. Seven treatments, consisting of 2.5% metaldehyde integrated with various attractants (beer, wheat bran, rice bran, fruit, cabbage) and yeast, were evaluated under both open field conditions and within a custom-engineered containment trap. In open baiting, the beer-infused formulation proved superior, recording the highest overall mean catch of 10.44 snails, followed closely by the wheat bran bait with 9.50 snails. To prevent environmental degradation of the baits, a cylindrical plastic trap (25 cm height, 16 cm base) featuring three soil-level entry ramps and a 6 cm deep basal reservoir was developed. Deploying the poison baits inside these physical enclosures catalyzed substantial interception surges across all treatments compared to exposed layouts. The trap-housed beer bait achieved a maximum aggregate average of 15.39 targeted pests, representing a 47.41% increase in efficacy over its open counterpart, while rice bran traps demonstrated a 55.95% capture enhancement. The study concludes that blending toxicants with vigorously fermenting carbohydrate or liquid matrices, and situating them inside weather-resistant pitfall traps, provides a highly effective and ecologically sound strategy for terrestrial snail suppression.

Keywords: Snail management, Poison baits, Metaldehyde, Snail trap, Olfactory attractants, Soybean

Introduction

Gastropods, particularly terrestrial snails and slugs, represent a highly destructive polyphagous pest complex capable of consuming over 500 varied plant types (Jadhav *et al.*, 2016; Bhattacharyya *et al.*, 2014) [2, 1]. Fuelled by simultaneous hermaphroditic reproduction and extended aestivation cycles, massive nocturnal populations aggressively devour vulnerable plant parts, triggering severe economic deficits in commercial agriculture (Bhattacharyya *et al.*, 2014; Chavan, 2024) [1, 3]. In Maharashtra, population explosions of the giant African land snail (*Achatina fulica*) have compromised over 72,000 hectares of Kharif plantings, disproportionately devastating soybean and legume crops (Neharkar *et al.*, 2025) [4]. Standard mitigation protocols relying on the generalised broadcasting of synthetic chemical molluscicides, such as metaldehyde pellets, face profound practical limitations; these chemicals degrade rapidly during heavy monsoon rains, lack natural olfactory attraction, and pose toxicity risks to non-target ecosystems (Sallam *et al.*, 2012; Patil *et al.*, 2015; Smith *et al.*, 2013) [6, 5, 7]. Overcoming these challenges necessitates the development of specialized, odour-based attractant matrices that fuse toxicants with vigorously fermenting food bases, such as beer or fruit waste, to actively draw pests from their daytime refuges (D'Souza, 2025; Veasey *et al.*, 2021) [8, 9]. Furthermore, housing these attractants within enclosed physical structures protects the active ingredients from intense weather degradation and prevents target escape (Roda *et al.*, 2018; Minott *et al.*, 2018) [11, 10]. Therefore, the present investigation was undertaken to compare the efficiency of different fermenting poison baits and to develop a customised, weather-resistant physical trap for the optimised management of snails in soybean fields.

Materials and methods

Experimental Site and Treatment Details: The field experiments were conducted during the Kharif 2025 season in a naturally infested soybean (*Glycine max* L.) plot located in Sadoli Khalsa, Kolhapur district, Maharashtra. The trials were laid out in a Randomized Block Design (RBD) comprising seven treatments replicated three times. The treatments were formulated by supplementing specific food bases with 20 g of active dry yeast (acting as a fermenting olfactory attractant) and 50 g of 2.5% metaldehyde dry pellets (acting as the toxicant). The specific attractant bases evaluated were: 400 ml beer (T_1), 250 g wheat bran with 250 ml water (T_2), 250 g rice bran with 50 g jaggery and 250 ml water (T_3), 500 g papaya fruit with 100 ml

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water (T_4), and 500 g cabbage leaves with 100 ml water (T_5). These were tested against a standard chemical bait consisting of 200 g metaldehyde pellets with 200 ml water and 20 g yeast (T_6), alongside an untreated water control (T_7).

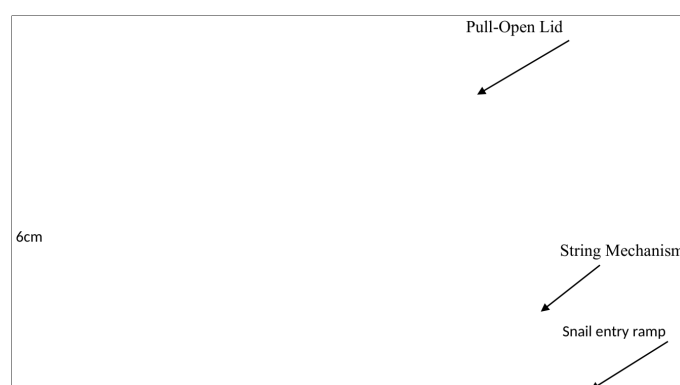
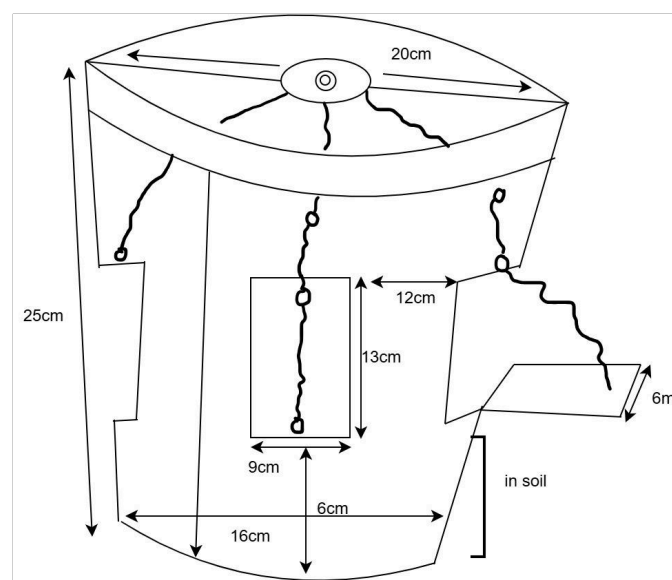
Open baiting evaluation (Phase I)

To assess the baseline efficiency of the poison baits without physical containment, the formulations were placed randomly within the designated experimental plots (5.0 m × 4.0 m), maintaining a sufficient buffer to prevent cross-interference. To preserve optimal trapping efficiency and bait freshness in the open field, each poison bait was completely replaced at 2-day intervals. Field observations were recorded by physically counting the number of dead snails on and immediately surrounding the baits at sequential intervals of 2, 4, 6, 8, 10, and 12 Days After Placement (DAP).

Trap construction and evaluation (Phase II)

To mitigate environmental degradation of the baits, a customized physical trap was fabricated using a cylindrical plastic container measuring 25 cm in total height, 16 cm in basal width, and featuring a 20 cm pull-open lid. Three rectangular access windows (13 cm height × 9 cm width) were cut into the sides, strategically positioned 6 cm above the base to retain an intact bottom reservoir for holding toxic liquids without soil seepage. The cut window materials were bent outward to create extending ramps. The traps were buried in a 6 cm deep soil pit, allowing the entry ramps to rest completely flat on the ground, creating a continuous moisture gradient that guided nocturnal snails into the enclosure. A string mechanism was installed to pull the ramps closed during lid removal, preventing spillage during maintenance. The seven previously described poison bait formulations were placed inside these traps and replenished at 4-day intervals. The absolute number of dead or trapped snails was recorded at 3, 6, 9, 12, 15, and 18 DAP.

Snail entry ramp



Pull-Open Lid
6 cm

Figure 1. Schematic diagram of the modified snail trap.

Statistical analysis

The raw trap catch data recorded from each replication across all observation intervals were compiled independently. To normalise the variance, the data were subjected to square root transformation using $\sqrt{x + 0.5}$. The transformed data were analyzed utilizing Analysis of Variance (ANOVA) for RBD, and the significance of treatment variations was tested using the *F*-test at a 0.05 probability level.

Result and discussion

Efficacy of poison baits under open field conditions

Field evaluations demonstrated that combining 2.5% metaldehyde with actively fermenting dietary substrates drastically improved target capture rates compared to utilizing the standalone chemical or unbaited controls. The beer-infused formulation emerged as the most potent olfactory attractant, securing the highest overall mean catch of 10.44 snails per observation. This was closely followed by the wheat bran matrix, which achieved an overall mean of 9.50 snails. Fruit and rice bran baits displayed robust to intermediate attraction, recording overall means of 8.56 and 5.38 snails, respectively. Conversely, the unenhanced metaldehyde and cabbage-based baits yielded weak capture aggregates of just 3.83 and 2.66 snails, while the water control persistently recorded the lowest interception rate at 0.56 snails.

DAP- Days after placement. *Figures in parentheses are $\sqrt{x + 0.5}$ transformed values.

The overwhelming superiority of the beer and wheat bran baits confirms that highly fermentable liquid and carbohydrate mediums are optimal gastropod attractants. The addition of yeast accelerates fermentation, releasing concentrated volatiles that successfully draw snails from greater distances, a dynamic strongly supported by Patil et

Table 1. Treatment details and composition of the evaluated poison baits.

Treatment no.	Details of Poison baits
T_1	Beer Bait (400 ml beer + 20 gm yeast + 50 gm metaldehyde 2.5%)
T_2	Wheat bran bait (250 gm wheat bran + 250 ml water + 20 gm yeast + 50 gm metaldehyde 2.5%)
T_3	Rice bran bait (250 gm rice bran + 50 gm jaggery + 250 ml water + 20 gm yeast + 50 gm metaldehyde 2.5%)
T_4	Fruit bait (500 gm Papaya + 100 ml water + 20 gm yeast + 50 gm metaldehyde 2.5%)
T_5	Cabbage bait (500 gm Cabbage leaves + 100 ml water + 20 gm yeast + 50 gm metaldehyde 2.5%)
T_6	Metaldehyde bait (200 gm 2.5% Metaldehyde pellets + 200 ml water + 20 gm yeast)
T_7	Water (Control)

String Mechanism

al. (2015) [5] and Suzuki *et al.* (2025) [12]. Furthermore, the poor performance of standalone metaldehyde confirms that the toxicant itself is a weak attractant and routinely suffers from severe palatability deficits when natural vegetation is readily accessible, aligning with

findings by Smith *et al.* (2013) [7] and Laznik *et al.* (2010) [13]. Similarly, the cabbage bait failed because it presented no distinct aromatic contrast to pull snails away from the dense, established soybean canopy.

Table 2. Efficiency of different poison baits against snails under open conditions

Sr. No	Treatment	Mean No. of Snails trapped						
		2 DAP	4 DAP	6 DAP	8 DAP	10 DAP	12 DAP	Mean
1	Beer Bait	8.33 (2.97) *	10.67 (3.34)	12.00 (3.53)	12.67 (3.63)	11.67 (3.49)	7.33 (2.80)	10.44 (3.31)
2	Wheat bran bait	7.67 (2.86)	9.67 (3.19)	11.33 (3.44)	11.00 (3.39)	10.33 (3.28)	7.00 (2.73)	9.50 (3.16)
3	Rice bran bait	5.00 (2.34)	5.67 (2.48)	6.00 (2.54)	6.33 (2.61)	5.33 (2.41)	4.00 (2.11)	5.38 (2.42)
4	Fruit bait	6.67 (2.67)	8.00 (2.91)	10.00 (3.24)	10.33 (3.29)	9.67 (3.19)	6.67 (2.68)	8.56 (3.01)
5	Cabbage bait	2.33 (1.68)	3.33 (1.95)	2.67 (1.77)	3.33 (1.95)	2.33 (1.68)	2.00 (1.56)	2.66 (1.78)
6	Metaldehyde bait	3.33 (1.93)	4.67 (2.23)	3.67 (2.03)	4.33 (2.16)	4.00 (2.11)	3.00 (1.86)	3.83 (2.08)
7	Water (Control)	0.33 (0.88)	0.33 (0.88)	0.67 (1.05)	1.00 (1.17)	0.67 (1.05)	0.33 (0.88)	0.56 (1.03)
SE		0.11	0.15	0.12	0.14	0.13	0.10	0.13
CD at 5%		0.35	0.46	0.36	0.42	0.57	0.32	0.47
CV%		9.05	10.71	8.04	9.12	9.34	8.73	9.93

Performance of the custom snail containment trap

When these identical toxic mixtures were housed inside the custom-fabricated cylindrical traps, capture frequencies surged significantly. The beer bait trap remained the most effective treatment, recording a

peak overall mean catch of 15.39 snails per trap. The wheat bran (13.56 snails) and fruit baits (12.17 snails) also maintained their high-performance rankings inside the enclosures.

Table 3. Efficacy of different poison baits in traps

Sr. No	Treatment	Mean No. of Snails trapped						Mean
		3 DAP	6 DAP	9 DAP	12 DAP	15 DAP	18 DAP	
1	Beer Bait	13.00 (3.67)*	17.33 (4.22)	18.00 (4.30)	17.00 (4.15)	16.33 (4.10)	10.67 (3.32)	15.39 (3.99)
2	Wheat bran bait	11.00 (3.39)	15.00 (3.93)	16.33 (4.10)	15.33 (3.98)	14.00 (3.79)	9.67 (3.19)	13.56 (3.75)
3	Rice bran bait	7.33 (2.79)	9.00 (3.06)	10.00 (3.24)	9.33 (3.12)	8.00 (2.90)	6.67 (2.68)	8.39 (2.98)
4	Fruit bait	10.33 (3.28)	13.67 (3.76)	14.67 (3.89)	13.33 (3.71)	12.67 (3.62)	8.33 (2.97)	12.17 (3.56)
5	Cabbage bait	3.33 (1.93)	4.33 (2.18)	4.67 (2.26)	4.00 (2.11)	3.00 (1.87)	3.00 (1.87)	3.72 (2.05)
6	Metaldehyde bait	4.33 (2.20)	5.33 (2.41)	6.00 (2.54)	6.33 (2.59)	4.00 (2.11)	3.67 (2.03)	4.94 (2.33)
7	Water (Control)	0.33 (0.88)	0.67 (1.05)	1.33 (1.29)	1.33 (1.34)	1.00 (1.22)	0.67 (1.05)	0.89 (1.18)
SE		0.14	0.16	0.15	0.15	0.17	0.14	0.15
CD at 5%		0.44	0.51	0.46	0.48	0.53	0.43	0.47
CV%		9.59	9.66	8.44	8.95	10.62	9.93	9.53

DAP- Days after placement. *Figures in parentheses are $\sqrt{x} + 0.5$ transformed values.

Transitioning the baits into the engineered devices yielded an immense relative performance increase across all treatments when benchmarked against the exposed layouts. Rice bran generated the steepest percentage jump among the dietary baits (55.95%), followed by beer (47.41%), wheat bran (42.74%), and fruit (42.17%). Even the

weaker cabbage and standalone metaldehyde variants experienced capture boosts of 39.85% and 28.98%, respectively.

These analytical findings confirm that the engineered containment unit cultivated an optimal, shaded microclimate that served as a highly attractive artificial aggregation zone during daytime thermal stress. By sinking the trap base 6 cm into the soil, the device established an uninterrupted damp pathway that guided nocturnal snails directly up the flanged entry ramps. Existing literature thoroughly en

dorses these structural advantages; Raudenbush *et al.* (2021) [14] and Rabelo *et al.* (2022) [15] confirmed that modified pitfall frameworks with moisture reservoirs create significantly cooler microclimates that aggressively pull in heat-averse gastropods. Most essentially, elevating the side access windows generated a fully sealed lower basin.

This design stopped the lethal fluid mixtures from leaching into the soil, shielded the fermenting attractants from intense monsoon downpours, and entirely thwarted intercepted pests from escaping, mirroring the highly successful bucket trap mechanics validated by Minott *et al.* (2018) [10] and Roda *et al.* (2018) [11]

Table 4. Comparative efficacy and percentage increase of Trap Baiting over Open Baiting

Treatments	Open Baiting	Trap Baiting	Percentage increase
Beer Bait	10.44	15.39	47.41
Wheat bran bait	9.5	13.56	42.74
Rice bran bait	5.38	8.39	55.95
Fruit bait	8.56	12.17	42.17
Cabbage bait	2.66	3.72	39.85
Metaldehyde bait	3.83	4.94	28.98

Summary and conclusion

The present investigation evaluated the efficacy of various fermenting poison baits and the structural advantages of a custom-engineered containment trap for managing terrestrial snails in soybean ecosystems. Under open field conditions, blending 2.5% metaldehyde with actively fermenting carbohydrate or liquid substrates—particularly beer and wheat bran—drastically improved target capture rates compared to utilizing standard chemical pellets in isolation. The beer-infused formulation emerged as the dominant olfactory attractant, securing an overall mean catch of 10.44 snails, which translated to a 2.73-fold surge in capture capability relative to the baseline metaldehyde layout. Conversely, metaldehyde and cabbage-based attractants yielded weak interception rates, proving that bare chemical agents lack sufficient sensory pull within densely vegetated agricultural environments.

To circumvent the ecological and structural vulnerabilities of exposed bait stations, a specialized, weather-resistant cylindrical trap was developed. Situating the toxic baits inside these physical enclosures catalyzed substantial interception surges across every tested group, with the beer-infused trap achieving a maximum aggregate average of 15.39 snails per unit, representing a 47.41% increase over open baiting. The trap's design—featuring a sealed lower liquid reservoir, extended entry ramps, and an overhead canopy—successfully halted chemical drainage into the soil, shielded the aromatic components from harsh solar rays and torrential rains, and entirely thwarted intercepted individuals from escaping. Ultimately, the research solidifies that maximizing pest eradication requires physically blending killing agents into a vigorously fermenting matrix and housing them within specialized physical enclosures to ensure reliable, long-term population mitigation.

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