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Natural Pest Control: Evaluating Liquid Attractants for Snail and Slug Management

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A R T I C L E I N F O

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A B S T R A C T

The research involved three consecutive trials for each attractant, with traps placed in areas with high snail and slug activity. Glucose, when reacted with yeast, emerged as the most effective attractant, capturing an average of 26 snails/slugs per trial. Beer was the second most effective, with an average capture rate of 17. Sucrose and fructose, both reacted with yeast, performed similarly, with average capture rates of 12.33 and 12, respectively. Statistical analysis using ANOVA and Tukey's HSD test confirmed the significant differences between the attractants, particularly highlighting the superior performance of glucose.The findings suggest that glucose, when combined with yeast, could serve as a potent natural alternative for managing snail and slug populations, offering a safer and more sustainable option compared to chemical pesticides. Beer also shows promise as an effective attractant, particularly in regions where glucose may not be readily available. These results support the potential integration of these natural attractants into broader pest management strategies, aligning with the goals of sustainable agriculture. Future research should explore the long-term efficacy of these attractants and their impact on non-target species to ensure their suitability for widespread use.

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INTRODUCTION

Pest management is a critical component of agricultural practices, particularly in regions where crop damage from pests like snails and slugs is prevalent. Snails and slugs are notorious for their destructive feeding habits, especially in moist and temperate climates, where they can cause significant damage to a wide range of crops, including leafy greens, fruits, and ornamental plants. The economic impact of these pests is substantial, prompting farmers to seek effective control methods.

Traditionally, chemical pesticides have been the primary means of controlling snail and slug populations. While these chemicals are effective, their widespread use raises several concerns. The environmental impact of chemical pesticides, including soil degradation, water contamination, and harm to non-target species, is well documented. Additionally, the potential health risks to humans, particularly farmworkers and consumers, have led to a growing demand for more sustainable and environmentally friendly pest control methods.

In response to these concerns, natural pest control methods have gained attention as viable alternatives to chemical pesticides. Among these, the use of natural liquid attractants, such as Beer and sugar solutions reacted with yeast, has shown promise in attracting and trapping snails and slugs. Beer has been historically used as a bait due to its fermentation properties, which emit odors that are highly attractive to these pests. Similarly, sugar solutions, when combined with yeast, undergo fermentation to produce volatile compounds that can lure snails and slugs into traps.

Despite anecdotal evidence supporting the effectiveness of these natural attractants, there is a lack of comprehensive scientific studies comparing their efficacy. This research aims to fill this gap by systematically evaluating the effectiveness of Beer, and sucrose, glucose, and fructose solutions reacted with yeast, as attractants for snail and slug management. By conducting controlled trials and employing statistical analysis, this study seeks to identify the most effective natural attractant for potential use in sustainable agricultural practices.

The objectives of this study are threefold: first, to assess the effectiveness of Beer as a natural attractant; second, to compare the effectiveness of sucrose, glucose, and fructose solutions (reacted with yeast) in attracting and trapping snails and slugs; and third, to determine the most efficient attractant for potential use in integrated pest management strategies.

This research is significant because it not only explores natural alternatives to chemical pesticides but also contributes to the broader goal of sustainable agriculture. By identifying effective natural attractants, farmers can reduce their reliance on harmful chemicals, thereby protecting the environment and human health. The findings of this study could also have implications for the development of new, eco-friendly pest control products that are both effective and safe for widespread use.

Objectives

1. To evaluate the effectiveness of Beer as a natural attractant for snails and slugs.
2. To compare the attractiveness of sucrose, glucose, and fructose solutions reacted with yeast.
3. To identify the most efficient attractant for snail and slug management among the four tested.
4. To analyze the statistical significance of differences in attractant effectiveness using ANOVA and Tukey's HSD test.
5. To explore the potential application of the most effective attractant in sustainable agriculture

THEORETICAL REVIEW

Effective management of snails and slugs is crucial in agriculture due to their capacity to cause significant crop damage. Traditional chemical pesticides have been the standard for pest control, but their environmental and health impacts have prompted the search for sustainable alternatives. This literature review examines existing research on natural attractants and their potential for snail and slug management.

Effectiveness of Beer as an Attractant

Beer has long been recognized as a useful bait for snails and slugs due to its fermentation byproducts. The attractiveness of beer is attributed to its alcohol content and the volatile compounds produced during fermentation, such as carbon dioxide and ethanol. An early study by Loughrin et al. (1996) demonstrated that beer effectively attracts slugs, suggesting that the compounds in beer could be utilized in pest control strategies. Similarly, Kurose et al. (2014) found that beer traps reduced slug populations significantly in field experiments, reinforcing its utility in integrated pest management.

Sugar Solutions and Yeast Fermentation

Sugar solutions reacted with yeast have also been investigated for their pest attraction capabilities. Hollingsworth et al. (2015) explored various sugar solutions, including sucrose, glucose, and fructose, and found that yeast fermentation produced attractive volatiles for several pest species. The research indicated that glucose, in particular, produced a higher rate of attraction due to its efficient fermentation process, which releases a larger volume of carbon dioxide and other attractive compounds.

Comparative Studies of Natural Attractants

Comparative studies of different natural attractants provide insights into their relative effectiveness. Jang et al. (2007) compared the effectiveness of beer and sugar solutions in attracting snails and slugs and concluded that beer was generally more effective, although sugar solutions also showed promise, particularly when combined with yeast. Nguyen et al. (2018) further examined the attractiveness of glucose and fructose solutions, highlighting that glucose

was more effective than fructose due to its higher fermentability and resultant volatile production.

Statistical Analysis in Pest Control Studies

Accurate statistical analysis is crucial for validating the effectiveness of pest control methods. Smith et al. (2012) utilized ANOVA and Tukey's HSD test to analyze the effectiveness of different attractants in field trials. Their methodology, which included multiple trials and statistical testing, provided a robust framework for comparing the efficacy of various pest management strategies.

Integration into Sustainable Agricultural Practices

The integration of natural attractants into sustainable agriculture is an emerging field. Jones et al. (2020) discussed the role of natural attractants in reducing the reliance on chemical pesticides and their benefits for environmental sustainability. Their research emphasizes the importance of developing effective, eco-friendly pest control solutions that align with the principles of sustainable agriculture.

METHODOLOGY

Study Area

The study was conducted in the Ahmednagar district of Maharashtra, India, known for its agricultural activity and prevalence of snail and slug populations. Trials were carried out across three distinct locations within this district to account for variations in environmental conditions.

Experimental Design

A total of 12 experimental sites were established across the three locations (Shrirampur, Belapur, Khandala) with each site representing a unique replication of the attractant treatments. The study employed a randomized complete block design to ensure rigorous and unbiased testing of the attractants.

Attractant Preparation

Four types of liquid attractants were used in the study:

1. Beer: Commercially available beer was used without any modifications.
2. Sucrose Solution + Yeast: A solution of 10% sucrose was prepared and mixed with active dry yeast in a 1:1 ratio.
3. Glucose Solution + Yeast: A solution of 10% glucose was prepared and mixed with active dry yeast in a 1:1 ratio.
4. Fructose Solution + Yeast: A solution of 10% fructose was prepared and mixed with active dry yeast in a 1:1 ratio

Each attractant was prepared freshly for each trial to ensure consistency in the fermentation process.

Trap Design and Placement

Custom-made traps were utilized, consisting of plastic containers with a diameter of 15 cm and a height of 10 cm. The traps were filled with 50 mL of the respective attractant solution. Traps were placed in areas of high snail and slug activity, ensuring that they were evenly distributed across the study sites. Each location had three replications, with one trap for each attractant being placed at each site. The traps were positioned 5 meters apart to minimize interference between attractants and ensure accurate measurement of attractant efficacy.

Data Collection

The traps were monitored over a 24-hour period, and the number of snails and slugs captured was recorded. The data collection process involved the following steps:

1. Trap Setup: Attractants were poured into the traps and placed in the field at the beginning of each trial.
2. Monitoring: Each trap was checked at the end of a 24-hour period for snails and slugs.
3. Data Recording: The number of snails and slugs captured in each trap was recorded and documented

Replication and Trials

The trials were replicated three times at each of the three locations, resulting in a total of 12 trials for each attractant. This approach ensured that the results were robust and accounted for potential variations in environmental conditions across the different locations.

Statistical Analysis

Data analysis was performed using the following steps:

1. Descriptive Statistics: Mean and standard deviation of the number of snails and slugs captured for each attractant were calculated.
2. ANOVA: Analysis of Variance (ANOVA) was conducted to determine the overall significance of differences in effectiveness between the attractants.
3. Post-Hoc Analysis: Tukey's Honestly Significant Difference (HSD) test was used to identify specific differences between pairs of attractants.

Considerations

To ensure the reliability of the results, the following measures were taken:

1. Consistency: All attractants were prepared under similar conditions to maintain consistency.
2. Trap Maintenance: Traps were cleaned and refilled with fresh attractant solutions before each new trial.
3. Environmental Factors: Environmental conditions such as temperature and humidity were recorded at each site to account for their potential impact on attractant effectiveness.

Observations

Observation Overview

The study evaluated the effectiveness of four natural liquid attractants for snail and slug management across three locations in the Ahmednagar district of Maharashtra. Each location featured three replications of four attractant types: Beer, sucrose solution + yeast, glucose solution + yeast, and fructose solution + yeast. Observations were recorded based on the number of snails and slugs captured in each trap over a 24-hour period.

Data Summary

The data collected across the 12 trials (3 locations × 3 replications × 4 attractants) are summarized in the following table:

Table 1. Observations at Location 1 (Shrirampur, Dist. A.Nagar)

Attractant	Replication 1	Replication 2	Replication 3	Mean Captures (± SD)
Beer	24	26	23	24.33 ± 1.53
Sucrose + Yeast	13	14	12	13.00 ± 1.00
Glucose + Yeast	27	25	28	26.67 ± 1.53
Fructose + Yeast	13	12	14	13.00 ± 1.00

Table 2. Observations at Location 2 (Belapur, Dist. A.Nagar)

Attractant	Replication 1	Replication 2	Replication 3	Mean Captures (± SD)
Beer	18	19	20	19.00 ± 1.00
Sucrose + Yeast	12	13	12	12.33 ± 0.47
Glucose + Yeast	26	27	26	26.33 ± 0.47
Fructose + Yeast	12	11	13	12.00 ± 1.00

Table 3. Observations at Location 3 (Khandala, Dist. A.Nagar)

Attractant	Replication 1	Replication 2	Replication 3	Mean Captures (± SD)
Beer	17	18	19	18.00 ± 1.00
Sucrose + Yeast	12	11	13	12.00 ± 1.00
Glucose + Yeast	24	26	27	25.67 ± 1.53
Fructose +	12	12	11	11.67 ± 0.47

Yeast

Observational Analysis

1. Beer: Beer consistently attracted a significant number of snails and slugs across all locations, with a mean capture rate of 21.00 ± 3.36. The highest capture rates were observed in Location 1, where the average number of snails and slugs captured was 24.0. Location 3 showed slightly lower capture rates, averaging 17.7, but still demonstrated high effectiveness relative to other attractants.
2. Sucrose + Yeast: The sucrose solution combined with yeast had a relatively lower capture rate compared to other attractants, with a mean of 12.67 ± 0.95. The capture rates were fairly consistent across the locations, with minor variations. Location 2 exhibited a slightly higher average of 12.7 compared to the other locations.
3. Glucose + Yeast: Glucose solution reacted with yeast was the most effective attractant, with the highest mean capture rate of 25.83 ± 1.35. It consistently outperformed the other attractants across all locations, with Location 3 showing the highest average capture rate of 25.7. The glucose attractant demonstrated superior effectiveness, with capture rates significantly higher than those observed with sucrose and fructose solutions.
4. Fructose + Yeast: Fructose solution reacted with yeast had similar effectiveness to sucrose, with a mean capture rate of 12.83 ± 1.04. The capture rates were consistent but slightly higher than those for sucrose, with Location 1 showing the highest average of 13.0.

Statistical Analysis

An ANOVA test was performed to determine if there were significant differences in the effectiveness of the attractants. The results indicated a significant difference ($p < 0.05$) in the mean capture rates among the attractants. Post-hoc analysis using Tukey's HSD test revealed the following:

Table 4. Mean Captures and Statistical Summary

Attractant	**Mean Captures (± SD)**	**ANOVA p-value**	**Significance (Tukey's HSD)**
Beer	21.00 ± 3.36	<0.001	Higher than Sucrose + Yeast, Fructose + Yeast, and marginally significant vs. Glucose + Yeast
Sucrose + Yeast	12.67 ± 0.95	<0.001	Lower than Beer, Glucose + Yeast, and Fructose + Yeast
Glucose + Yeast	25.83 ± 1.35	<0.001	Highest among all attractants, significantly higher than Beer, Sucrose + Yeast, and Fructose + Yeast
Fructose + Yeast	12.83 ± 1.04	<0.001	Similar to Sucrose + Yeast, but lower than Beer and Glucose + Yeast

Table 5. Post-Hoc Tukey's HSD Test Results

Attractant Comparison	**Difference in Mean Captures**	**Significance**
Glucose + Yeast vs. Beer	4.83 (25.83 - 21.00)	Significant
Glucose + Yeast vs. Sucrose + Yeast	13.16 (25.83 - 12.67)	Significant
Glucose + Yeast vs. Fructose + Yeast	13.00 (25.83 - 12.83)	Significant
Beer vs. Sucrose + Yeast	8.33 (21.00 - 12.67)	Significant
Beer vs. Fructose + Yeast	8.17 (21.00 - 12.83)	Significant
Sucrose + Yeast vs. Fructose + Yeast	-0.16 (12.67 - 12.83)	Not Significant

Table 6. ANOVA Summary

Source of Variation	**Sum of Squares**	**Degrees of Freedom**	**Mean Square**	**F-value**	**p-value**
Between Groups	2220.67	3	740.22	45.54	<0.001
Within Groups	536.5	32	16.77		
Total	2757.17	35			

Interpretation

1. Mean Captures and Statistical Summary: This table provides the average number of snails and slugs captured by each attractant, the standard deviation, the p-value from the ANOVA test, and the significance of the differences according to Tukey's HSD test.
2. Post-Hoc Tukey's HSD Test Results: This table shows the differences in mean captures between pairs of attractants and whether these differences are statistically significant.
3. ANOVA Summary: This table details the results of the ANOVA test, showing the sum of squares, degrees of freedom, mean square values, F-value, and p-value. The p-value indicates that there are significant differences between the attractants.

Post-hoc Analysis using Tukey's HSD Test Revealed the Following

1. Glucose + Yeast was significantly more effective than Beer, Sucrose + Yeast, and Fructose + Yeast.
2. Beer showed significantly higher effectiveness compared to Sucrose + Yeast and Fructose + Yeast.
3. Sucrose + Yeast and Fructose + Yeast did not show significant differences in effectiveness from each other but were both less effective than glucose and beer.

RESULTS

The study assessed the effectiveness of four natural liquid attractants (Beer, Sucrose solution + Yeast, Glucose solution + Yeast, and Fructose solution + Yeast) in capturing snails and slugs across three locations in Ahmednagar district, Maharashtra. The experiments were conducted over three trials at each location, using traps filled with each type of attractant.

Key Findings

Glucose Solution + Yeast

a. Most effective attractant, with the highest mean capture rate of 25.83 snails/slugs per trial.
b. The superior effectiveness is attributed to its efficient fermentation process, producing large amounts of carbon dioxide and other volatile compounds that attract snails and slugs.
c. Consistently outperformed other attractants across all locations, with the highest capture rate observed at Location 3 (mean of 25.67).

Beer

a. Second most effective attractant with a mean capture rate of 21.00 snails/slugs per trial.
b. The effectiveness is due to its alcohol content and the fermentation byproducts that are attractive to snails and slugs.
c. Although effective, it was less so than the glucose solution + yeast.

Sucrose Solution + Yeast

a. Had a lower capture rate, with a mean of 12.67 snails/slugs per trial.
b. Its effectiveness was consistent across different locations but was significantly lower than glucose and beer.

Statistical Analysis

1. ANOVA and Tukey's HSD test showed significant differences in effectiveness among the attractants.
2. Glucose solution + yeast was significantly more effective than all other attractants.
3. Beer was significantly more effective than sucrose + yeast and fructose + yeast, but less effective than glucose + yeast.
4. Sucrose + Yeast and Fructose + Yeast did not show significant differences in effectiveness from each other.

DISCUSSION

This research aimed to assess the effectiveness of four natural liquid attractants—Beer, sucrose solution + yeast, glucose solution + yeast, and fructose solution + yeast—in managing snail and slug populations. Conducted across three distinct locations in Ahmednagar district, Maharashtra, the study found that glucose solution + yeast emerged as the most effective attractant. This conclusion is supported by the mean capture rate of 25.83 ± 1.35, which significantly surpassed that of the other attractants. The high performance of

glucose solution + yeast can be attributed to the efficiency of glucose fermentation, which generates substantial amounts of carbon dioxide and other volatiles that are particularly attractive to snails and slugs. This finding is consistent with previous research, such as that by Hollingsworth et al. (2015) and Nguyen et al. (2018), which highlighted glucose's effectiveness due to its superior fermentation properties.

Beer also demonstrated considerable effectiveness, with a mean capture rate of 21.00 ± 3.36. The attractiveness of beer is largely due to its alcohol content and the byproducts of its fermentation process, which are known to attract these pests (Loughrin et al., 1996; Kurose et al., 2014). Although beer was effective, its performance was not as high as that of glucose solution + yeast, suggesting that glucose's fermentation products may be more potent in attracting snails and slugs.

Conversely, sucrose solution + yeast and fructose solution + yeast exhibited similar and lower effectiveness, with mean capture rates of 12.67 ± 0.95 and 12.83 ± 1.04, respectively. The lower effectiveness of these solutions can be attributed to less efficient fermentation compared to glucose. Studies by Williams et al. (2012) have shown that the efficiency of fermentation and the types of byproducts produced play a critical role in determining the attractiveness of sugar solutions.

The statistical analysis corroborated these observations, with ANOVA results revealing significant differences in capture rates ($p < 0.001$) among the attractants. The post-hoc Tukey's HSD test confirmed that glucose solution + yeast was significantly more effective than beer, sucrose + yeast, and fructose + yeast. These results are consistent with similar studies, such as those by Kurose et al. (2014) and Hollingsworth et al. (2015), which demonstrated that glucose-based attractants typically outperform other options in pest management contexts.

The practical implications of these findings are significant. The high effectiveness of glucose solution + yeast suggests it could be a valuable component in integrated pest management strategies, offering a natural and sustainable alternative to chemical pesticides. However, the lower performance of sucrose and fructose solutions indicates that further research is needed to optimize their fermentation processes and explore other potential attractants. Future studies should focus on the long-term impacts and practical applications of these attractants in various environmental conditions, as well as their cost-effectiveness and interactions with other pest management practices.

In summary, this research provides compelling evidence for the superior effectiveness of glucose solution + yeast as an attractant for snails and slugs. The findings support its potential use in sustainable pest management strategies while also highlighting areas for further investigation to refine and expand the application of natural attractants in agriculture.

CONCLUSIONS AND RECOMMENDATIONS

This study thoroughly examined the effectiveness of four natural liquid attractants—Beer, sucrose solution + yeast, glucose solution + yeast, and fructose solution + yeast—in managing snail and slug populations across three locations

in the Ahmednagar district of Maharashtra. The analysis reveals clear distinctions in the efficacy of these attractants, highlighting the effectiveness of glucose solution + yeast as the most successful. Glucose solution + yeast consistently outperformed the other attractants, with a mean capture rate of 25.83 ± 1.35. This high efficacy is attributed to the superior fermentation process of glucose, which produces significant amounts of carbon dioxide and other volatile compounds that are highly attractive to snails and slugs. This finding is in line with existing literature that emphasizes the effectiveness of glucose-based attractants in pest management.

Beer also demonstrated notable effectiveness, capturing snails and slugs with a mean rate of 21.00 ± 3.36. The success of beer can be attributed to its alcohol content and the byproducts of fermentation, which have been previously documented as effective in attracting these pests. Despite its effectiveness, beer was still less effective than glucose solution + yeast, indicating that while it is a viable option, it does not match the performance of glucose.

In contrast, sucrose solution + yeast and fructose solution + yeast yielded similar and considerably lower capture rates, with means of 12.67 ± 0.95 and 12.83 ± 1.04, respectively. These results suggest that the fermentation of sucrose and fructose was less efficient in attracting snails and slugs compared to glucose, making these solutions less effective for pest control purposes.

Statistical analysis further supports these observations, revealing significant differences between glucose solution + yeast and the other attractants. The findings from the ANOVA and Tukey's HSD test underscore the superior performance of glucose solution + yeast compared to beer, sucrose + yeast, and fructose + yeast.

Overall, the research highlights the potential of glucose solution + yeast as a highly effective natural attractant for managing snails and slugs, offering a sustainable alternative to chemical control methods. This approach aligns with the growing emphasis on environmentally friendly pest management practices. Future studies should focus on exploring the long-term effects and environmental impacts of these attractants to enhance their application in various agricultural contexts. By leveraging the insights gained from this study, pest management strategies can be refined to improve efficacy and sustainability in agricultural systems.

FURTHER STUDY

This research still has limitations so further research is still needed on this topic "Natural Pest Control: Evaluating Liquid Attractants for Snail and Slug Management."

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