Study of Plant Extracts and Insecticides in a Biological Control Program

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Abstract.

For many years, Iraqi agriculture relied heavily on synthetic insecticides to solve the problem of pest infestations. These chemicals have been effective on a short-term basis, however their continued use creates many issues that cannot be overlooked. Many pest populations have developed a resistance to the use of synthetic insecticides over time. Rather more, the use of synthetic insecticides has negative effects on beneficial organisms. As such, the need for new pest management approaches is becoming clearer every day. One area of interest is in plant-derived compounds not necessarily to replace synthetic insecticides altogether but to use them as potential elements in more integrated pest management programs. The studies evaluated the efficiency of neem (Azadirachta indica), garlic (Allium sativum) and eucalyptus (Eucalyptus globulus) extract materials compared to common synthetic pesticides also their ability to kill insects as well as what is traditionally done, while also taking into consideration whether or not they alter behavior or affect the growth and development of larvae. These subjects play a important role in giving you a complete understanding of pest control. The findings indicate that neem extract appears to be effective in killing insects, especially during extended periods of exposure; the death rates are similar to those found with synthetic pesticides. Garlic and eucalyptus would be considered to have a moderate effect relative to neem. However, both plant materials were shown to have consistent effectiveness in terms of reducing feeding activity and slowing the growth of larvae. A key finding is that many of the different plant extracts were found to act through multiple mechanisms, which could reduce the possibility of insects developing resistance over time. The total result has suggested the possibility of improving pest management programs by introducing plant-based solutions to Iraq. Based on the results obtained through this study, there is a clear basis for moving forward with an overall strategy that uses domestic plant resources as part of an IPM approach. As synthetic pesticides continue to provide rapid action for serious problems, the use of plant extracts provides the option of enhanced environmental compatibility and support for long-term sustainability.

Key words: - Plant Extracts, Insecticides, Biological Control Program

***Tob Regul Sci.™ 2026 ;12(1):* 1 - 7**

دراسة مستخلصات النباتات والمبيدات الحشرية في إطار برنامج مكافح حيوي

الملخص

لأعوام طويلة، اعتمدت الزراعة العراقية بشكل كبير على المبيدات الحشرية الاصطناعية لحل مشكلة تفشي الآفات الزراعية. وقد أثبتت هذه المواد الكيميائية فعاليتها على المدى القصير، إلا أن استمرار استخدامها يخلق العديد من المشكلات التي لا يمكن التغاضي عنها. فقد طورت العديد من حشرات الآفات مقاومة تجاه المبيدات الحشرية الاصطناعية مع مرور الزمن. علاوة على ذلك، تؤثر هذه المبيدات سلبًا على الكائنات الحية غير المستهدفة. وبناءً عليه، أصبحت الحاجة إلى أساليب جديدة في إدارة الآفات أكثر وضوحًا يومًا بعد يوم.

تتمثل إحدى المجالات المثيرة للاهتمام في المركبات المشتقة من النباتات، ليس بالضرورة لاستبدال المبيدات الحشرية الاصطناعية بالكامل، وإنما لاستخدامها كأدوات محتملة ضمن برامج إدارة متكاملة للآفات. وقد هدفت الدراسة إلى تقييم كفاءة مستخلصات كل من النيم (Azadirachta indica) والثوم (Allium sativum) والكافور (Eucalyptus globulus) مقارنة بالمبيدات الكيميائية الاصطناعية الشائعة، من حيث قدرتها على قتل الحشرات بالإضافة إلى تأثيرها في سلوك الحشرات أو نموها وتطور يرقاتها — وهي جوانب أساسية لفهم شامل لمكافحة الآفات.

تشير النتائج إلى أن مستخلص النيم يظهر فعالية ملحوظة في قتل الحشرات، لا سيما خلال فترات التعرض الممتدة، إذ تصل معدلات القتل إلى مستويات مماثلة لتلك التي تحققها المبيدات الاصطناعية. في حين يمكن اعتبار كل من مستخلصي الثوم والكافور أقل فعالية من النيم، إلا أنهما أظهرا فعالية متوسطة واتساقًا في تقليل النشاط الغذائي للآفات وإبطاء نمو اليرقات. كما كشفت الدراسة أن العديد من هذه المستخلصات النباتية تعمل من خلال آليات متعددة، مما يقلل من احتمال تطوير الحشرات للمقاومة بمرور الوقت.

تشير النتائج الكلية إلى إمكانية تحسين برامج إدارة الآفات من خلال دمج الحلول النباتية في الزراعة العراقية. وبناء على النتائج التي تم الحصول عليها، هناك أسس واضحة للتوسع في استراتيجية شاملة تستخدم الموارد النباتية المحلية كجزء من نظام الإدارة المتكاملة للآفات. فبينما توفر المبيدات الاصطناعية فعالية سريعة للحالات الحرجة، فإن استخدام المستخلصات النباتية يوفر خيارًا متوافقًا مع البيئة ويدعم الاستدامة طويلة الأجل.

الكلمات المفتاحية: مستخلصات نباتية، مبيدات حشرية، برنامج المكافحة الحيوية

Introduction

Iraqi agriculture operates in conditions that are not always easy to deal with. The high heat and sporadic rain and also the increasing pressures on the surrounding environment allow pest populations to develop very quickly in these conditions (1). Managing pests in these environments must be not only to enhance yield but also to maintain the primary source of food (2). Synthetic insecticides have been the main tool to fight against pests for decades where they are effective at controlling pest populations anyway, their effectiveness does not always lead to sustainable use. Throughout time, many unintentional results have developed. One of the most common is resistance (3). Pests that have been continuously treated with a particular pesticide develop resistance to that pesticide. As the pest begins adapting to that pesticide, it also causes farmers to use more pesticide, or to switch to a stronger pesticide than they previously used (4). This can cause a dramatic increase in both environmental and economic costs. Concerns about pesticides are not limited to just resistance to pesticides; there are also other types of pesticides that are less obvious but still important (5). An example would be synthetic insecticides that cannot always tell the difference between beneficial and non-beneficial organisms. Pollinators, beneficial microorganisms found in soil, and natural predators of pests can all be harmed by the use of synthetic insecticide (6). As a result of this harm, the ecological balance becomes disrupted, and even secondary pest populations may outbreak as a result. Attention has been drawn increasingly to other alternatives due to the aforementioned problems associated with the use of chemical pesticides. More specifically, there has been increased use of plant-derived insecticides (botanicals) (7). In contrast to synthetic chemicals, many botanical extracts are mixtures that contain many different types of active compounds (8). Because there are so many ways in which these compounds can act on insects (feeding, growth, reproduction, and/or behavior), the adaptability or resistance of pests may be more difficult to develop; however, it is not known if this increases the likelihood of pests developing resistance (9). Often referred to as one of the most effective plant-based insecticides, Neem, or Azadirachta indica, has gained considerable support due to its ability to disrupt the hormone regulation of insects via its active ingredient, azadirachtin, disrupting their normal feeding and growth patterns (10). Garlic, or Allium sativum, provides a different means of insect control due to its high levels of sulfur compounds, such as allicin, which alter cellular functions. Eucalyptus, or Eucalyptus globulus, produces essential oils that inhibit nervous system activity in insects resulting in decreased activity and feeding (11). Although there are several benefits to using plant extracts in agriculture, the use of these materials on a large scale is minimal. Numerous studies have been done in laboratories, where results do not consistently correlate with results obtained in the field (12). Therefore, there is a gap between what is currently known about using plant extracts and what could be accomplished by using them to grow crops. This project will attempt to fill this gap (13). We do not want to suggest that plantderived extracts are intended to take the place of chemically synthetic insecticides. Our interest is to investigate both methods' success in working with real-life situations, instead of comparing plant versus chemical techniques, and if plant based treatments see increased use regarding pest management future plans.

Materials and Methods

The research was done on farms in Central Iraq. The weather there is dry and has temperature from 25 to 38 degrees celsius. The moisture in the air was between 30 - 55%. These conditions were good for insects to live in. 2.2 Plant Material and Extraction Plant materials were collected locally, which was considered important for ensuring practical relevance (14). The selected species included neem, garlic, and eucalyptus. Once collected, the materials went through a washing process to remove any contaminations and were then air-dried at a controlled temperature and humidity (15). The materials were then ground into a fine powder. Ethanol was used as the extraction solvent with a Soxhlet extractor; this extraction method was selected because it permits continuous extraction and provides optimal recovery of bioactive compounds from plant sources. The extract was then evaporated with a rotary evaporator to concentrate the extract before being stored in refrigeration until further use (16).

Table 1. Selected Plant Extracts and Characteristics

No.	Plant Name	Scientific Name	Active Compound	Extraction Method
1	Neem	*Azadirachta indica*	Azadirachtin	Soxhlet (ethanol)
2	Garlic	*Allium sativum*	Allicin	Ethanol extraction
3	Eucalyptus	*Eucalyptus globulus*	Cineole	Steam distillation

Two insecticides were selected for comparison, these shows the typical chemical control strategies used in Iraqi agriculture. RCBD (randomized complete block design) will be the study method employed in this experiment. For all treatments, three replications will be utilized, with the exception of control plots (control plots will receive distilled water only) (17).

Table 2. Synthetic Insecticides Used

No.	Insecticide	Active Ingredient	Concentration	Mode of Action
1	Insecticide A	Imidacloprid	0.05%	Neurotoxic
2	Insecticide B	Cypermethrin	0.1%	Sodium channel disruption

Measurements were observed and collected at 24, 48, and 72 hours after treatment, and will thus include: Pest mortality, feeding behaviours, mobility and larval development.

Table 3. Experimental Design

Treatment Code	Description
T1	Neem extract
T2	Garlic extract
T3	Eucalyptus extract
T4	Insecticide A
T5	Insecticide B
T6	Control

Results and Discussion

All of the treatments experienced an increase in death over time as expected. Overall, synthetic insecticides produced a significantly higher percentage of pest deaths versus neem extract, although neem extract produced an almost equally high percentage of pest deaths at 72 hours (18).

Table 4. Pest Mortality (%)

Treatment	24h	48h	72h
Neem	48	70	88
Garlic	32	52	68
Eucalyptus	28	50	72
Insecticide A	65	85	96
Insecticide B	60	82	94
Control	6	9	12

The performance of neem is noteworthy because it doesn't have the same quick action as synthetic agrochemicals; nevertheless, the efficacy of neem gradually increased until it was equivalent to agrochemicals (19). While both garlic and eucalyptus appear to be slower and less intense than neem and synthetic chemicals, they both provide valuable contributions (20).

Table 5. shows the larval Growth Reduction (%)

Treatment	Growth Reduction
Neem	78
Garlic	58
Eucalyptus	62
Insecticide A	88
Insecticide B	85

The neem has the strongest effect on development. Garlic and eucalyptus show moderate inhibition effect, which may still be useful when combined with other control methods (21).

Table 6. shows the behavioral effects

Treatment	Feeding Activity	Mobility
Neem	Strong reduction	Severely reduced
Garlic	Moderate reduction	Slight reduction
Eucalyptus	Moderate reduction	Reduced
Insecticides	Immediate stop	Immobilized

Sometimes behavioral changes may not seem to be as important however they are. Insects do not always die immediately but a decrease in feeding may help to significantly reduce damage to crops (22). Synthetic pesticides have a longer residual life, which can be beneficial; however, there are some environmental issues associated with the use of synthetic pesticides (23). Plant-derived insecticides will break down sooner than synthetic insecticides and this may have positive implications in some situations (24). The results combined indicate that plant extracts have actual promise, although they likely won't provide the complete solution by themselves. Synthetic pesticides can currently offer immediate pest control, which cannot be fully displaced. However, as time passes, synthetic pesticides appear to have more negative effects in the long run (25) On the other hand plant extracts provide a more balanced method of working. While they may not be as fast acting, they affect a number of different aspects of the pest, potentially causing a great deal less environmental damage (26, 27). This balance is particularly critical in a system such as Iraq's, where environmental and resource-related issues can be troublesome.

Conclusion

According to this report, it was observed that neem (Azadirachta indica) and other plants have potential as effective ingredients for biological controls of pests. Although synthetic insecticides are essential for immediate suppression of insect populations or other pest issues, they represent a much less sustainable source of pest control compared to plant derived materials. Instead of replacing conventional chemicals with alternative type products, a combination of both may create a more viable future for farmers. Therefore, it is feasible that integrating plant-derived extracts into an existing pest management strategy can help reduce reliance on synthetic pesticides and enhance long-term viability or sustainability for agricultural production in Iraq. The direction appears to be clear, with continued research to improve extraction methods, improve formulation stability and conduct larger scale testing supporting these types of approaches, which will be towards a more integrated chemical and biological system as opposed to two separate competing processes.

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