



Article

Field evaluation of nano and conventional acaricides against Broad Mite (*Polyphagotarsonemus latus*) on potato

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Abstract

A field study was conducted to evaluate four different acaricide compounds (nano acramite 480 SC, normal acramite 480 SC, nano spiroidiclofen, and normal spiroidiclofen) to control the broad mite (*Polyphagotarsonemus latus*) infestation on potato under field conditions in Yusufiya region, Baghdad, Iraq. Results indicated significant differences in mobile and egg stages of mites during the experiment. The nanoparticles acaricides reduced the *P. latus* population significantly more than the normal acaricides. The nano acramite and spiroidiclofen reduced the mite mobile stage to 3.2 and 4.8 individuals/leaf, respectively, 2 weeks after spraying. Similarly, egg populations were significantly minimized to 10.1 and 17.2 eggs/leaf. These findings, supported by Tukey-Kramer means separation ($P \leq 0.05$), demonstrate that nanoparticle applications can suppress mobile stages by over 80% and eggs by over 90% compared to conventional formulations. The findings of this study support the concept of using eco-friendly materials as a component in *P. latus* management strategy.

Keywords: Acramite 480 SC; spiroidiclofen; *Polyphagotarsonemus latus*; integrated pest management; potato.

Received: 22/5/2026

Revised: 13/8/2026

Accepted: 10/9/2026

Published: 30/9/2026

Citation: Aljuboory AB. Field evaluation of nano and conventional acaricides against broad mite (*Polyphagotarsonemus latus*) in potato. JSPPB. 2026;1:26-32.

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التقييم الحقلي لمبيدات الحلم النانوية والتقليدية ضد الحلم ذوالرسغ الشعري (*Polyphagotarsonemus latus*) على محصول البطاطا
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المستخلص

أجريت دراسة حقلية لتقييم أربعة مركبات مختلفة من مبيدات الحلم (أكاراميت SC 480 نانوي، وأكاراميت SC 480 تقليدي، وسبيروديكلوفين نانوي، وسبيروديكلوفين تقليدي) لمكافحة الإصابة بالحلم ذوالرسغ الشعري (*Polyphagotarsonemus latus*) على محصول البطاطا تحت الظروف الحقلية في منطقة اليوسفية ببغداد، العراق. أظهرت النتائج وجود فروق معنوية في أعداد الأطوار المتحركة وأعداد البيض للحلم أثناء التجربة؛ حيث أدت مبيدات الحلم النانوية إلى خفض أعداد *P. latus* بشكل أكبر وبفارق معنوي مقارنة بالمبيدات التقليدية. فقد خفض كل من "أكاراميت" و "سبيروديكلوفين" بصيغتهما النانوية أعداد الأطوار المتحركة للحلم لتصل إلى 3.2 و 4.8 فرد/ورقة على التوالي، وذلك بعد أسبوعين من الرش. وبالمثل، انخفضت أعداد البيض بشكل معنوي لتصل إلى 10.1 و 17.2 بيضة/ورقة. وتُظهر هذه النتائج -التي تم تأكيدها إحصائياً باستخدام اختبار Tukey-Kramer للمقارنة بين المتوسطات (عند مستوى $P \leq 0.05$)- أن استخدام التركيبات النانوية يمكن أن يحد من

الأطوار المتحركة بنسبة تزيد عن 80% ومن أعداد البيض بنسبة تزيد عن 90% مقارنة بالتركيبات التقليدية. وتدعم نتائج هذه الدراسة مفهوم استخدام مواد صديقة للبيئة كجزء من استراتيجية إدارة ومكافحة حشرة/آفة *P. latus*.

1. Introduction

Potato (*Solanum tuberosum* L) is considered one of the most important crops in Iraq and the world (1). Human potato consumption ranks fourth after wheat, rice, and corn (2). The potato crop is used as a main dish and in chips and other industries (3). Given the importance of potato crops in Iraq's food security, the agricultural production structure needs to upgrade agricultural policies towards optimal use of agricultural resources and sustainable development, encourage the use of modern agricultural technologies, expand the use of high-quality plant varieties that are resistant to the different pests and abiotic factors (4). In Iraq, potato is grown in open fields in two seasons, spring and fall (5). According to the Iraq Commission of Statistics and GIS (<http://cosit.gov.iq/ar/agri-stat/veg-prod>), the production of potatoes in Iraq was 466,127 t in 2021. There are various serious pests on potato plants in the agricultural industries worldwide, including two-spotted mite *Tetranychus urticae*, whitefly, *Bemisia tabaci*, cutworms, *Agrotis ipsilon*, and armyworms *Spodoptera* sp. feeding on vegetation part of potato plants are commonly found in warm areas and considered a polyphagous pest (6, 7).

Polyphagotarsonemus latus is reported as one of the most devastating pests on potato crop in Baghdad province, Central Iraq (8). *P. latus* typical symptoms are marked by the curling and browning of the apical leaves (9). If the infestation starts early and continues, the older leaves start curling downwards. A darker color on leaves may develop and may inhibit plant growth following the mite attack (10).

Arthropods and pathogens are major biotic factors affecting crops (11). Several different insecticides are commonly used to control piercing-sucking insects and mite pests from different chemical classes. Because of the side effects of using pesticides, studies have tended to introduce safer alternative ways in order to control different pests (12). The misuse of pesticides leads to pesticide residues, and environmental pollution which causes the ability of pests to develop resistance to insecticides (13).

Scientific research is focusing on developing and producing products that have a positive effect on the environment. For example, finding a way to reduce pesticide spraying on crops by detecting or developing a new gene of resistance to single or multiple pests in a plant or crop thus reducing the application of chemicals in the ecosystem and at the same time increasing crop yield (14, 15, 16). This research is investigating employment of nanoparticles as acaricides (17). This work has included evaluating nanoparticles toxicity against pathogens and arthropod pests (18). However, the effects against *P. latus* are poorly highlighted. The use of nanoparticle technology innovation helps to reduce crop losses and can be utilized in integrated pest management (10). The widespread use of pesticides on potatoes is a major human and environmental health hazard that should be addressed by developing a comprehensive strategy for integrated pest management (IPM) strategies. Thus, this study aimed to use the nanoparticle as an innovative and eco-friendly method to control *P. latus*.

2. Materials and Methods

This field study was conducted in the Yusufiyah region, Baghdad Governorate, Iraq, for the fall 2024 and spring 2025 growing seasons. The field was prepared by tillage, and a randomized complete block experiment was designed with three replicates. Each block contained five treatments (nano acramite, nano spirodiclofen, normal acramite, normal spirodiclofen, and a water control), resulting in a total of 15 experimental units; treatments were randomly assigned within each block. Potatoes variety Elite Bureen seed tubers were grown on the raised beds 10 cm in height. The distance between each plant was 25 cm. After the germination of potato tubers agricultural practices included weed removal, fertilization, and regular irrigation. The field was kept free from the use of chemical pesticides, and the plants were left to allow for natural infestation by pests. The identity of *P. latus* was verified by the DNA marker following AlShabar et al. (8).

The acaricides were applied once using a manual pressure sprayer at the manufacturer's recommended field concentration (0.3 ml/L). Nano-formulations were prepared to match the active ingredient concentration of the conventional (normal) formulations to ensure a direct comparison of efficacy.

Mite populations were monitored at 2, 4, 7, and 14 days post-application. In each treatment plot, ten plants were randomly tagged. From each plant, three leaves (from the upper, middle, and lower canopy) were collected to provide representative means of the mobile and egg stages per leaf.

The data for the mite development population were analyzed using the PROC FREQ procedure (19). Paired comparisons of controls and chemical components were tested for significance using Fisher's exact test of P values (20). Mite population data were managed using the means calculated from the ten plants per component, subjected to ANOVA using PROC GLIMMIX (8). Means, when significantly different ($p \leq 0.05$), were separated by Tukey's (honestly significant difference) procedure (21).

3. Results

The results in Figure 1 show that the nanoparticles form compounds suppress the *P. latus* population significantly more than the normal form. At 14 days post-application, Nano Acramite had the lowest population density of 3.2 individuals/leaf, which was significantly lower than its conventional counterpart (10.1). The control population increased to 47.9 individuals/leaf by the end of the trial (Figure 1).

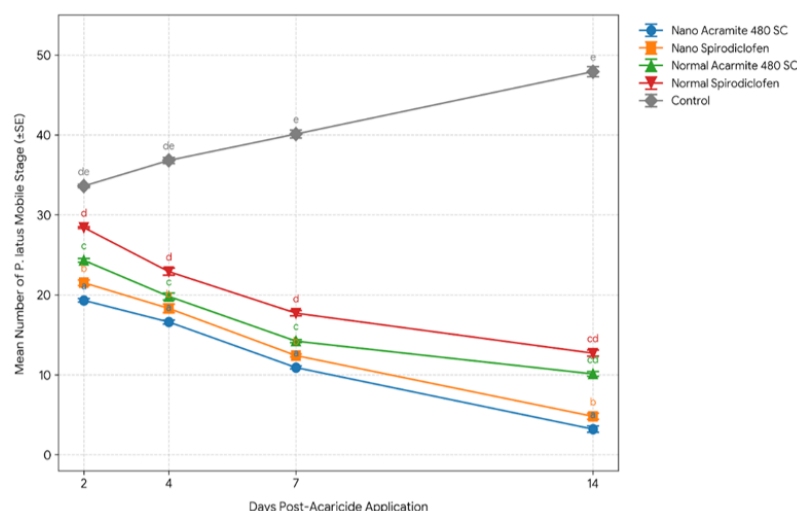


Figure 1. Population dynamics of the broad mite, *Polyphagotarsonemus latus*, on potato plants following the application of different acaricide formulations. Mean number of mobile stages per leaf. Data are presented as the mean $\pm$ standard error (SE) evaluated at 2, 4, 7, and 14 days post-

application. Treatments include nano-formulated and conventional (normal) Acramite 480 SC and Spirodiclofen, compared to an untreated control.

The results in Figure 2 show that the nanoparticles form compounds reduce the egg of *P. latus* significantly more than the normal form compounds. Nano acramite and nano spirodiclofen significantly minimized the mite egg numbers at 14 days after acaricide application compared to the normal compounds and the control.

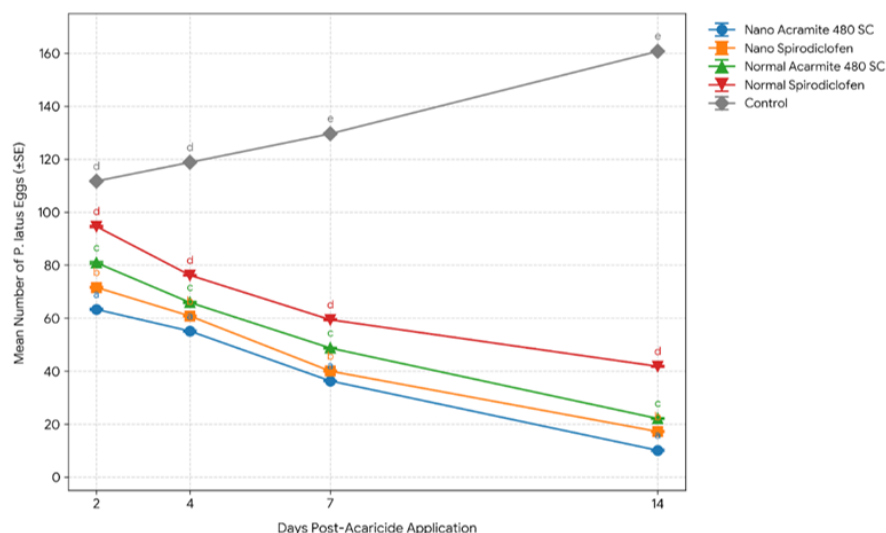


Figure 2. Population dynamics of the broad mite, *Polyphagotarsonemus latus*, on potato plants following the application of different acaricide formulations. Mean number of eggs per leaf. Data are presented as the mean $\pm$ standard error (SE) evaluated at 2, 4, 7, and 14 days post-application. Treatments include nano-formulated and conventional (normal) Acramite 480 SC and Spirodiclofen, compared to an untreated control.

4. Discussion

Chemical substances such as pesticides, acaricides, fungicides, etc. increase crop yields which can help the economy grow (22). However, frequent exposure to chemicals may elevate biotic and abiotic factors (23). In addition, this increases the chances of soil, water, and air pollution. Therefore, eco-friendly components (24, 25), are alternatives that will decrease pollution and restore the environment (26). The keystone of eco-friendly nature is eco-friendly products which are important ways to save the environment from pollution, as well as to increase the productivity of the crops. Using eco-friendly nanotechnology pesticides as an alternative to synthetic pesticides is a new approach to suppress the pest population and keep the environment clean. The concept of integrated pest control is used in plant genes to reduce the effect of the wheat curl mite on wheat production (27). Gatta et al. (28) found positive results supporting the idea of using biological control when they used crude extracts in low concentrations to control *P. latus*.

In this trial components nano acramite and nano spirodiclofen were the most effective in reducing egg hatchability, while the normal component of acramite had a moderate effect on egg hatchability compared to the control. A study highlighted the efficiency (97.22%) of spirodiclofen in controlling *Brevipalpus yothersi* on the seventh day after application (29). Therefore, choosing suitable component pesticides to control any pest should take into consideration the plant responses to infestation. This data clearly highlighted that acramite and spirodiclofen in the nano form were more toxic to the mite eggs than the normal form. Derbalah et al. (30) found that cyhalothrin and fenpyroximate were

the most toxic against the two-spotted mite egg (30). Another report showed that the repellence and the anti-feeding of the mushroom crude methanol extract had an excellent efficiency (61.7%) in controlling maize weevil *Sitophilus zeamais* (31).

The remarkable efficacy of the nano-formulated acaricides observed in this study holds significant implications for sustainable pest management. The ability of nano-acaricide and nano-spirodiclofen to achieve superior control of *P. latus* mobile stages and eggs with potentially lower active ingredient concentrations or fewer applications compared to their conventional counterparts is a critical advantage. Reducing chemical loads in agricultural systems directly translates into minimized environmental impact, decreased risk of off-target contamination of soil and water, and mitigating potential harm to beneficial insects and non-target organisms. Furthermore, by providing highly effective control, these advanced formulations can lead to higher crop yields and reduced economic losses for farmers, while potentially slowing the development of pesticide resistance through more targeted and efficient action. While synthetic pesticides often lead to environmental residues, the use of nano-formulated acaricides presents a potential strategy to reduce chemical loads. This approach aligns with IPM goals by achieving higher efficacy at potentially lower application frequencies, thereby mitigating (rather than eliminating) the overall environmental impact. In conclusion, it is very important to monitor and search for new pests (32) in order to control them, before pest outbreaks, in an eco-friendly manner by using new technology (33-36). Chemicals in general, and specifically pesticides, have been utilized extensively in many agricultural practices to increase crop yields and to control pests. These compounds are often applied in much higher doses than those required to control pests. Sustainability in agriculture is vital and can be achieved by applying all required techniques to achieve the Sustainable Development Goals.

5. Conclusions

The results of this study revealed the potential benefits of using nanoparticle technology when applying acaricides to reduce the amount of pollution in the environment including soil pollution and to reduce human health risk exposure. Although more experiments in fields and greenhouses are required to further evaluate other nanoparticle acaricide products, it provides a new understanding of the nanoparticle pesticide uptake process by the pests.

Funding: This research received no external funding.

Acknowledgments: The author would like to thank the University of Baghdad.

Conflicts of Interest: The author declares no conflicts of interest.

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