



Article

Evaluation of Various Pesticides for Controlling *Tetranychus urticae* Koch and *Bemisia tabaci* (Genn.) Infesting Watermelon Plants

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<https://doi.org/10.37229/fsa.fja.2025.12.03>

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Future Science Association

Available online free at
www.futurejournals.org

Print ISSN: 2687-8151

Online ISSN: 2687-8216

Received: 1 October 2025

Accepted: 18 November 2025

Published: 3 December 2025

Publisher's Note: FA stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Abstract: A field evaluation of various pesticides was conducted on two piercing-sucking pests in watermelon crops during the two successive growing seasons of 2024 and 2025, in Fayoum Governorate, Egypt. Four commercial synthetic pesticides were selected: Hexythiazox and Abamectin against spider mite *Tetranychus urticae* Koch, and Imidacloprid and Pyriproxyfen against whitefly *Bemisia tabaci* Genn. Beside two bio-rational pesticides, Anti-insect (mineral oil) and Potassium soap were also applied against both pests. The objective of this study was to assess the effectiveness of the mineral oil and Potassium soap in controlling these pests compared to chemical compounds. The experiment was carried out with four treatments with four replicates each. The results showed the effectiveness of all tested compounds in reducing the two pests' populations. Hexythiazox and Abamectin demonstrated the highest and most immediate effectiveness in reducing mite populations after the first day of treatment, with rates of 93.1% and 91.8% for Hexythiazox, and 92.8% and 89.2% for Abamectin during the first and second spray seasons, respectively. For whitefly, Imidacloprid and Pyriproxyfen achieved control rates of (92.6% and 92.4%), and (90.4% and 90.9%) during the first and second application seasons, respectively. Anti-insect and Potassium soap achieved the highest reduction rates after the third day of treatment, (81.7% and 80.1%) and (86.8% and 81.0%) for mite, and (80.4% and 75.7%), and (83.5% and 83.3%) for whitefly in the first and second spray seasons, respectively. Overall, Hexythiazox recorded the highest average reduction (86.5%), followed by Imidacloprid (84.9%), while the lowest average reduction (70.4%) was recorded with Potassium soap. Based on these results, Anti-insect and Potassium soap could be considered effective and safe alternatives to traditional pesticides in specialized agricultural production systems such as organic farming.

Key words: Sucking pests, *Tetranychus urticae* Koch, whitefly *Bemisia tabaci*, alternative pesticides, watermelon.

1. Introduction

Watermelon, *Citrullus lanatus* (Thunb.), is one of the important vegetable crops belonging to the family Cucurbitaceae. It is a globally cultivated fruit with significant commercial value (Nissar *et al.* 2025). The crop is commercially grown in areas with long frost free warm period (Majid, 2011). China, Turkey, Iran, Brazil, United State, Egypt and Russian federation are the major watermelon producers (FAO, 2010 and Guo *et al.*, 2013). In Egypt it is mainly a summer vegetable crop. The total cultivated area reached 49363 fedden (fed.) in 2023 producing 694352 tons with an average yield of 14.07 tons/fed. (Anonymous, 2024).

The watermelon fruit is known to be a good source of lycopene and carotenoid. It is also high in fibre and citrulline (Oyeleke *et al.*, 2012). Watermelon seeds have an economic importance especially in countries where cultivation is on the increase (Bukar 2023). Seeds contain high nutritional and bioactive contents. They are rich in fats, proteins, vitamins, and minerals and they also contain bioactive compounds such as phenolic acids, flavonoids, and carotenoids. (Trease *et al.*, 2002; Tiwari *et al.*, 2011; Boakye *et al.*, 2015 and Nissar *et al.*, 2025).

The watermelon crop is mainly infested by several sucking pests viz; whitefly, aphids, thrips and tetranychid mites (Shintre *et al.*, 2023). These pests cause severe damages whereas feed on the phloem sap, leading to plant weakening and renders the fruits unmarketable (Adel *et al.* 2018; Farag and Korish 2025). Furthermore, these pests are known to be vectors that transmit phytopathogens especially viral diseases, posing an additional threat to watermelon crop ((Duffus, 1987; Srinivasan, 2009 and Abou El-Saad 2015).

Although synthetic pesticides are effective in controlling sucking pests however, massive use of such compounds has a number of disadvantages such as their high cost, toxicity to natural enemies and adverse environmental effects (Manjula *et al.* 2018). Moreover, the indiscriminate use of pesticides can lead to pests developing resistance to pesticide action, leading to the recurring appearance of pests in recent years (Miller 2004). In addition, heavy doses of insecticides have posed problems of residue in the fruits which causing human hazards upon consumption. Nevertheless, the chemical pesticides can be minimized by integrating them with botanical and microbial pesticides for producing healthy and good quality crop (Pawar *et al.* 2019; Shintre *et al.* 2023).

Therefore, intensified search for alternative strategies of pest control were carried out (Marsaro 2009). Among the strategies available, botanical insecticides represent one of the promising approaches to control the vegetable pests (Ali *et al.* 2019), also biological pesticide suggests an effective solution to pest problems (Gupta 2010; Manjula *et al.* 2018).

So, the present work aimed to assess effectiveness of two alternatives pesticides, including one mineral oil and Potassium soap, compared to known applied chemical pesticides, in controlling the spider mite *Tetranychus urticae* Koch, and the whitefly *Bemisia tabaci* so additional safe choices that suit different agricultural production regimes such as organic agriculture could be introduced.

2. Materials and Methods

The experiment design

The experiment was conducted during the 2024 and 2025 seasons on watermelon in Ibshway, Fayoum Governorate, Egypt. The total cultivated area was approximately 1,600 m², divided into four plots of about 400 m² each. Each plot was subdivided into four equal replicates of 100 m², arranged in a Randomized Complete Block Design.

Pesticides application

As shown in Table (1), six compounds were tested on the two piercing-sucking pests; Hexythiazox, Abamectin, Anti-insect, and Potassium soap were used against the spider mite *Tetranychus urticae* Koch (mobile stages), while Imidacloprid, Pyriproxyfen, Anti-insect, and Potassium soap were used against whitefly *Bemisia tabaci* Genn. (nymphs). The treatments were applied when infestation reached the control threshold using a knapsack motor sprayer.

Table (1). Description of tested pesticides and their application rates

Common name	Trade name	Usage rate
Hexythiazox	Macomite 10% WP	20gm/100L water
Abamectin	Bermectine 1.8% EC	40cm ³ /100L water
Imidacloprid	Ema Agro 35% SC	75 cm ³ /100L water
Pyriproxyfen	General 10% EC	75 cm ³ /100L water
Paraffin oil	*Anti-insect 28% EC	1Liter/200L water
Potassium soap	*Potassium soap 12% EC	1Liter/150L water

*Produced by Central Lab. of Organic Agriculture, Agricultural Research Center, Egypt

Sampling and evaluation

Twenty leaves per replicate were taken randomly at intervals 1, 3, 7, and 10 days after treatment. Each sample picked leaves were held in separate sample bag, properly labeled and individually examined in the laboratory under a binocular. The efficiency of tested treatments was evaluated as a percentage of reduction in pest population density using the **Henderson and Tilton formula (1955)**.

Statistical analysis

Obtained data was subjected to one-way analysis of variance (ANOVA), and the values were compared at 5% level. Mean values of variables were separated by Duncan's multiple range test (Duncan 1955) ($p \leq 0.05$).

3. Results and Discussion

I- Effectiveness of treatments against *Tetranychus urticae*

First season, 2024

The data presented in Table (2) showed that Hexythiazox and Abamectin were the most effective in reducing the mite population, recording the highest reduction rates of (93.1 & 92.6%) and (91.8 & 92.9) after the 1st and 3rd day of treatment, respectively. Then effectiveness gradually decreased to (83.0 & 77.2%) and (77.5 & 74.6%) after the 7th and 10th day, respectively. In contrast, the effect of the treatments with Anti-insect and Potassium soap were less effective, where the highest reduction rate of 81.7 and 80.1% recorded after the 3rd day, gradually decreasing to a minimum of 77 and 68.4% after the 10th day, respectively (Table 2). These results were coincided with the findings obtained by **Ibrahim and Al-Shannaf (2017)** who demonstrated that the insecticides, Dinotefuran and Parathionmethyl showed the highest reduction of *T. urticae* after 24h, while the highest effect of Spinosad and Azadirachtin was after 3 days of treatment

Second season, 2025

By the 2nd spray season, similar effects were obtained with Hexythiazox and Abamectin, but with less effectiveness compared to those obtain after the 1st one. The highest reduction values of 92.8 and 89.2% were recorded after the 1st day, after that effectiveness gradually decreased, reaching lowest reduction values of 65.9 and 67.1% recorded after the 10th day of treatment, respectively as shown in Table (2).

Anti-insect and Potassium soap were less effective in reducing pest population, with the highest reduction value of 86.8 and 81% recorded after the 3rd day, then effectiveness decreased to the lowest reduction values of 59.6 and 60.7% and 40% after the 10th day of spraying, respectively (Table 2). In related study, **Ali *et al.* (2016)** reported that chemical control with Diamond and Confidor against mite on brinjal through the two spraying periods showed the highest effect followed by plant extracts;

Neem, Tobacco and Eucalyptus, respectively. Similar results were obtained by **Kumar *et al.* (2023)** who found that synthetic pesticide Clofentazine was effective to control mite population 89.96% followed by Cyflumetofen (81.04%, while biopesticides NSKE recorded (52.32%) by Azadirachtin (46.52%). Likewise, **Singh *et al.* (2014)** and **Singh *et al.* (2017)** investigated in a comparative study between synthetic acaricides and biopesticides and they found that Clofentazine was the most effective against spider mite among all tested pesticides.

Table (2). Effectiveness of various tested substances in the field against *Tetranychus urticae* populations on watermelon plants during the 2024 and 2025 seasons

2024 season									
Treatments	Sample Intervals After Spray								R %
	1 day	r %	3 days	r %	7 days	r %	10 days	r %	
Hexythiazox	2.28 ±0.35a	93.1	1.63 ±0.33a	92.6	5.58 ±1.12a	83.0	10.93 ±2.8b	77.2	86.5
Abamectin	2.45 ±0.06a	91.8	1.55 ±0.65a	92.9	8.33 ±1.27b	77.5	12.60 ±1.94b	74.6	84.2
Anti-insect	6.18v ±1.20b	77.8	6.33 ±1.79b	81.7	5.10 ±0.74a	78.6	5.35 ±1.79a	77.0	78.8
Potassium soap	10.78 ±1.63c	78.4	9.55 ±1.94c	80.1	18.88 ±1.76c	68.8	19.73 ±2.19c	68.4	73.9
ANOVA	***		***		***		***		
LSD5%	1.652		2.079		2.69		2.78		
2025 season									
Treatments	Sample Intervals After Spray								R %
	1 day	r %	3 days	r %	7 days	r %	10 days	r %	
Hexythiazox	2.45 ±0.79a	92.8	6.7 5±1.81a	80.8	13.15 ±1.21a	71.9	15.40 ±2.78a	65.9	77.9
Abamectin	4.03 ±1.58a	89.2	7.03 ±1.7a	82.7	13.58 ±1.78a	69.5	16.63 ±1.27a	67.1	77.1
Anti-insect	7.75 ±1.77b	75.2	3.70 ±2.59a	86.8	13.40 ±1.56a	68.4	15.65 ±2.35a	59.6	72.5
Potassium soap	7.53 ±2.08b	77.6	5.28 ±3.42a	81.0	13.83 ±1.80a	65.7	16.88 ±1.14a	60.7	71.3
ANOVA	***		ns		ns		ns		
LSD5%	2.281		4.212		2.633		2.534		

The represented data are means ± SD followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test ($p \leq 0.05$). r % and R % average and overall average reduction of pest population, respectively. LSD5% stands for Least Significant Difference at a 5% significance level.

II- Effectiveness of treatments against *Bemisia tabaci*

First season, 2024

The results in Table (3) indicated that Imidacloprid and Pyriproxyfen were the most effective in reducing pest population, recording the highest reduction rates of (92.6 & 91.1%) and (92.4 & 91.8%) after the 1st and 3rd days of treatment, thereafter decreased to (78.3 & 76.2%) and (70.4 & 67.6%) after the 7th and 10th day, respectively. This result is confirmatory with **Singh *et al.* (2004)** and **Bharpoda *et al.* (2014)** who indicated that Imidacloprid was significantly effective in population reduction of whitefly. On the other hand, the effectiveness of Anti-insect and Potassium soap was lower, with the highest reduction rate of 80.4 and 75.7% recorded after the 3rd day, then decreasing significantly to 76.2 and 67.6% after the 7th and 10th day, respectively (Table 3).

Second season, 2025

Likewise, Imidacloprid and Pyriproxyfen recorded the highest reduction rates of 90.4 and 90.9% were recorded after the 1st day of spraying, yet the effect gradually decreasing to 64.0 and 64.0% after the 10th day, respectively (Table 3). Similar results were found by **El-Sayed (2013)**, **Kumawat *et al.* (2015)** and **El-Dewy *et al.* (2018)** who confirmed that Imidacloprid was significantly effective in population reduction of whitefly. Furthermore, **Thorat *et al.* (2020)** and **Al Dhafar *et al.* (2024)** indicated that Imidacloprid showed superior efficacy, among all the pesticides tested, in suppressing whitefly, aphids and thrips populations on sweet pepper during two application periods. However, the highest effect of Anti-insect and Potassium soap reached 83.5 and 83.3% after the 3rd day, after that the effectiveness decreased to the lowest reduction rates of 58.0 and 57.3% after the 10th day, respectively (Table 3).

Table (3). Effectiveness of various tested substances in the field against *Bemisia tabaci* populations on watermelon plants during the 2024 and 2025 seasons

2024 season									
Treatments	Sample Intervals After Spray								R %
	1 day	r %	3 days	r %	7 days	r %	10 days	r %	
Imidacloprid	2.45 ±0.44a	92.6	1.83 ±0.21a	91.1	8.40 ±1.56b	80.6	10.68 ±1.23b	75.2	84.9
Pyriproxyfen	2.25 ±0.66a	92.4	1.75 ±0.39a	91.8	9.20 ±1.18b	78.0	11.93 ±0.82b	72.7	83.7
Anti-insect	5.43 ±2.30b	79.5	6.00 ±2.54b	80.4	4.95 ±0.62a	78.3	5.55 ±0.60a	76.2	78.6
Potassium soap	12.10 ±1.75c	74.3	12.35 ±2.17c	75.7	19.00 ±2.29c	70.4	19.65 ±1.60c	67.6	72.0
ANOVA	***		***		***		***		
LSD5%	2.45		2.468		2.666		1.642		
2025 season									
Treatments	Sample Intervals After Spray								R %
	1 day	r %	3 days	r %	7 days	r %	10 days	r %	
Imidacloprid	3.78 ±1.37a	90.4	6.83 ±1.52a	83.4	13.85 ±1.77a	71.0	14.78 ±2.13a	64.0	77.2
Pyriproxyfen	3.58 ±0.96a	90.9	8.03 ±1.61a	80.8	12.25 ±1.63a	70.0	16.25 ±1.88a	64.0	76.4
Anti-insect	7.83 ±3.03b	79.5	5.53 ±2.86a	83.5	14.35 ±1.98a	64.9	15.03 ±1.96a	58.0	71.5
Potassium soap	8.78 ±1.48b	75.5	4.58 ±2.91a	83.3	12.75 ±2.47a	65.6	16.50 ±1.40a	57.3	70.4
ANOVA	**		ns		ns		ns		
LSD5%	2.58		3.236		3.027		1.69		

The represented data are means ± SD followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test ($p \leq 0.05$). r % and R % average and overall average reduction of pest population, respectively. LSD5% stands for Least Significant Difference at a 5% significance level.

In general, Hexythiazox and Imidacloprid recorded the highest overall average reduction rates of 86.5 and 84.9%, after the 1st season, while the lowest overall average reduction rates were recorded in the 2nd season with Potassium soap 71.3 and 70.4% for the spider mite and whitefly, respectively (Table 2 and 3). Although there was a significant difference in the direct effects between the synthetic compound and the other two compounds, the overall average reduction did not vary significantly across the two spraying seasons for any of the tested compounds. Moreover, these results indicate that the overall average reduction rates during the first spraying season are higher than those in the second season, potentially due to increased average pest populations during the second application season.

Similar findings were reported by **Ali *et al.* (2017)** who found that the average reduction percentage of whitefly population on brinjal was higher in the 1st spray than in the 2nd one. Furthermore, our results revealed that the mineral oil and plant extract were also effective in controlling these two pests compared to the commercial chemical pesticides, as the lowest reduction percentages recorded throughout the evaluation period were 59.6% and 57.3% for Anti-insect and Potassium soap for mites and flies, respectively. These results is supported by the findings of **Solangi *et al.* (2015)** who found that the Neem and Tobacco proved effective in controlling spider mites on okra, but at moderate rates compared to the chemical pesticide, which gave high effectiveness. The overall average reduction of Anti-insect and Potassium soap reached (78.8 & 73.9%) and (72.5 & 71.3%) on spider mite, and (78.6 & 72.0%) and (71.5 & 70.4%) on whitefly, in the first and second seasons, respectively. These results are supported by the findings of **Horowitz and Ishaaya (2004)**, **Biswas *et al.* (2015)** who suggested that bio-rational insecticides are good alternatives and they can be used in the IPM programs.

3. Conclusion

The present results clarify that tested commercial pesticides are the most effective in controlling the target two pests with a rapid and immediate effect in reducing their populations compared to the tested Potassium soap and mineral oil which showed less efficiency however gave noticeable results in reducing the two pests' populations days after treatment, nevertheless, the similar overall average values for reduction percentages for all tested compounds open choices for more promising alternatives that can be employed in different integrated pest management programs specially for those under restricted agricultural production systems such as organic agriculture.

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تقييم أنواع مختلفة من المبيدات ضد نوعين من الآفات الثاقبة الماصة في نباتات البطيخ

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الملخص

أجري تقييم حقل لأنواع مختلفة من المبيدات على نوعين من الآفات الثاقبة الماصة على نباتات البطيخ خلال موسمي 2024 و 2025. تم اختبار أربعة مبيدات كيميائية تجارية : هيكسثييازوكس وأبامكتين لمكافحة أكاروس العنكبوت الأحمر (*Tetranychus urticae* Koch)، وإيميداكلوبريد وبيريبروكسيفين لمكافحة الذبابة البيضاء (*Bemisia tabaci* Genn). كما تم استخدام Anti-insect (زيت معدني) و Potassium soap لمكافحة كلا الآفتين. وكان الهدف من هذه الدراسة هو تقييم فعالية الزيت المعدني والصابون البوتاسي في مكافحة هذه الآفات مقارنةً بالمركبات الكيميائية. أجريت التجربة في أربعة معاملات، كل منها بأربعة مكررات. أظهرت النتائج فعالية جميع المركبات المختبرة في خفض أعداد الآفات المستهدفة. أظهر هيكسثييازوكس وأبامكتين أعلى فعالية وأسرعها في خفض أعداد *T. urticae* بعد اليوم الأول من المعالجة، بنسب (93.1% & 91.8%) و (92.8% & 89.2%) خلال الموسم الأول والثاني على التوالي. كما سجل كل من إيميداكلوبريد وبيريبروكسيفين نسب فعالية على *B. tabaci* بلغت (92.6% & 92.4%) و (90.9% & 90.4%) خلال الموسم الأول والثاني على التوالي. حقق كل من Anti-insect و Potassium soap أعلى معدلات للخفض بعد اليوم الثالث من المعاملة، حيث بلغت نسب الخفض في تعداد الآفة (81.7% & 80.1%) و (86.8% & 81.0%) بالنسبة لأكاروس العنكبوت الأحمر، و (80.4% & 75.7%) و (83.5% & 83.3%) بالنسبة للذبابة البيضاء خلال الموسم الأول والثاني على التوالي. إجمالاً، سجل هيكسثييازوكس أعلى متوسط انخفاض (86.5%)، يليه إيميداكلوبريد (84.9%)، بينما سُجل أدنى متوسط انخفاض (70.4%) مع الصابون البوتاسي. بناءً على النتائج التي تم الحصول عليها في هذه الدراسة يُمكن اعتبار كل من ال Anti-insect و Potassium soap بديلين فعالين وأمنين مقارنةً بالمبيدات التقليدية.

الكلمات الدالة : بدائل مبيدات الآفات ، الآفات الثاقبة الماصة ، *Tetranychus urticae* Koch, *Bemisia tabaci* ، البطيخ .