New Approaches for Controlling the European Red Mite, *Panonychus ulmi* (Koch) in Relation to Population Dynamics on Apple Trees

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ABSTRACT: The population dynamics of European red mite *Panonychus ulmi* (Koch) was affected by considerable factors, during two successive seasons 2020 and 2021, at Abu El-Matamir, EL- Beheira Governorate. Furthermore, the experimental work included two separate trial treatments. The first was directed for estimation the impact of the population dynamics, in addition to control above mentioned pest. While the second was directed to investigate the recent approach of agrochemical mixtures looking for new safe products against *P. ulmi*.

On the first experimental trial, the results indicated three peaks of activity regarding the infestation by *P. ulmi.* The first peak occurred at the 2nd week of May, the second peak was at the 2nd week of August, while the third peak was at the 1st week of October, during season 2020. Almost the same trend was obtained during season 2021.

The reduction percent of infestation was 97.7% season 2020 and 97.9% season 2021, showed that Fenbutatin-oxide was the most potent and active product against the *P. ulmi*. Followed by Abamectin 90.3% season 2020 and 90.4% season 2021. Both compounds Sulfur and Petroleum oil, were the least effective compounds achieving 60% average reduction. The recent approach to use agrochemicals against of *P. ulmi* (Abamectin, Chitosan, K. silicate, Petroleum oil and Sulfur) in addition to use the mixtures of half dose of Abamectin plus fixed dose of Petroleum oil, while Abamectin and 3/4 dose of Sulfur used in the application. Full dose of Chitosan and K. silicate were investigated against *P. ulmi*.

The data obtained indicated that (Abamectin + Chitosan) reduce the *P. ulmi* infection percent by 95.4% and (Abamectin + K. silicate) 94.6% were the most effective tested mixtures. Mixtures (Abamectin + P. oil) and (Abamectin + Sulfur) gave 93.7% and 92.6% infection reduction, respectively. Mixture (Chitosan + Sulfur) and (K. silicate + Sulfur) showed the least effective mixtures 82.9% and 81.8% infection reduction during the course of study2020. The days post-treatment (Abamectin + Chitosan) and (Abamectin + K. silicate) gave the most effective tested mixtures showed 95.2% and 94.1%, respectively. The reduction percent of *P. ulmi* showed that all mixtures gave considerable effect against of *P. ulmi* above 80%. Meanwhile, mixtures (Chitosan + Sulfur) and (K. silicate + Sulfur) showed the least effective mixtures 83.3% and 82.1% reduction duringthe course of study 2021, used as alternative for Fenbutatin-oxide for controlling of *P. ulmi* on apple crop.

Keywords: *Population dynamics, European red mite, (ERM) Panonychus ulmi, Mixtures, Agrochemical*

INTRODUCTION

Apple belongs to family Rosaceae is one of the most important nutritious fruit crops in the world. The chief apple producing countries are China, U.S.A, Germany, France, Japan, Russia, Argentina, Turkey, Italy, Spain and USSR **(Shahida Altaf, *et al.*, 2019).** The apple fruits are not only delicious and refreshing, but also a good source for water 80-85%, phenols, proteins 5%, or nitrogenous material and 10-15% of acids and salts, Carbohydrate, fats, sugars, vitamins, antioxidants and many other substances. and is amongst the most valuable of the antiscorbutic fruits for relieving scurvy **(Yishak Asalea *et al.*, 2021).**

Apple is infesting with many pests that threaten its success in Egypt and the world. The highest destructive pest is the *P. ulmi* which leads to a reduction in the quality and yield of apple fruits where mite feeding and destroys the rind cells **(Abd El-Wahed *et al.*, 2011).** This mite species is

infested apple trees and other plant species of family Rosaceae. Showed that developmental time from egg to adult to gave female and male varied from 12.6-23.2 and 10.6-18.6 days respectively **(Mohd Yaqoob Dar *et al*., 2015).**

Therefore, the present investigation was conducted to study the population dynamics of *P. ulmi* on Anna apple variety plus to evaluate certain agrochemical agents and their mixtures for controlling the *P. ulmi*, bio active mixtures and pesticides to reduce the amount of active ingredient on the apple crop.

MATERIALS AND METHODS

Monitoring the population dynamics of the European red mite *Panonychus ulmi* (Koch)

Experimental site

The experiments for estimating the population fluctuations of *P. ulmi*, were conducted at private orchard farm of apple trees in an area of about one feddan 10-years-old (Anna apple variety) apple trees 20 rows of trees ran from East to West (each row consisting of 13 tree) were examined through one year from beginning of January to late December. Leaf samples were collected weekly starting from start of January until late December of the same year.

Sampling and examination:

Twenty apple leaves weekly were taken randomly from trees and placed directly in paper bags and transported to the laboratory. All mite stages individuals (eggs, mature, immature stages, and adults) were counted using stereoscopic binocular microscope with the help of 20^x hand lens and mean numbers of *P. ulmi* were calculated. Meanwhile, the daily rates of temperature were taken from the central Meteorological Department, Ministry of Scientific Research during sampling periods.

The percentages of infestation reduction pre- and post-treatment application swere calculated according to the equation of **Henderson and Tilton (1955)** as follows:

$$\text{Reduction \%} = 1-[(\frac{A}{B})*(\frac{C}{D})]*100,$$

Where

A= Mean No. of mite individuals on leaves in treatment after spraying.

B= Mean No. of mite individuals on leaves in treatment before spraying.

C= Mean No. of mite individuals on leaves in the check before spraying.

D= Mean No. of mite individuals on leaves in the check after spraying.

Table (a) : Pesticide chemicals used in the 1st trial experiment

Trade name	Common name	Application rate (ml/100 liter)
Dumper (55 SC)	Fenbutatin-oxide	100
Tinam (1.8 EC)	Abamectin	50
Chitosacarid (4 EC)	Chitosan	250
K -silicate (40 EC)	Potassium silicate	400
K – oil (95 EC)	Petroleum oil	1000
Thiofan (80 WG)	Sulfur	200g

EC= Emulsifiable Concentrae, WG= Water dispersible Granules

Table (b): Pesticide chemicals used in the 2nd trial experiment

Trade name mixtures	Common name (mixtures)	Application rate (ml/100 liter)
Tinam + Thiofan (1.8 EC + 80 WG)	Abamectin + Sulfur	25 + 200 g
Tinam + K - oil (1.8 EC + 95 EC)	Abamectin + P. oil	25 + 1000
Tinam + K - silicate (1.8 EC + 40 EC)	Abamectin + K - silicate	25 + 400
Tinam + Chitosacarid (1.8 EC + 4 EC)	Abamectin + Chitosan	25 + 250
K – silicate + Thiofan (40 EC + 80 WG)	K. silicate + Sulfur	400+ 200 g
K – silicate + Chitosacarid (40 EC + 4 EC)	K. silicate + Chitosan	400+ 250
Chitosacarid + Thiofan (4 EC + 80 WG)	Chitosan + Sulfur	250 + 200 g

EC= Emulsifiable Concentrae, WG= Water dispersible Granules

RESULTS AND DISCUSSION

Population dynamic of the European red mite *Panonychus ulmi* (Koch) on apple trees during the course of study (2020 and 2021)

The first appearance of mite showed on April 14th and vanished on October 11th (season 2020 Fig. 1), while the second was on April 13th, and vanished on October 5th (season 2021 Fig. 1).

The data showed three activity peaks for the mite, in the first season, the first peak was appeared at the 2nd week of May (373 mite individuals/20 apple leaves), while the second peak was at the 1st week of June (384 mite individuals/20 leaves), and the third peak was at the 3rd week of August (482 mite individuals/20 leaves Fig. 1). **Cuthbertson A. G. S. (2000).**

The second season, the first higher peak was during the 2nd week of May (376 mite individuals/20 leaves), while the second peak was on the last week of June (359 mite individuals/20 leaves), and the third peak occurred at the 2nd week of August (411 mite individuals/20 leaves Fig. 1).

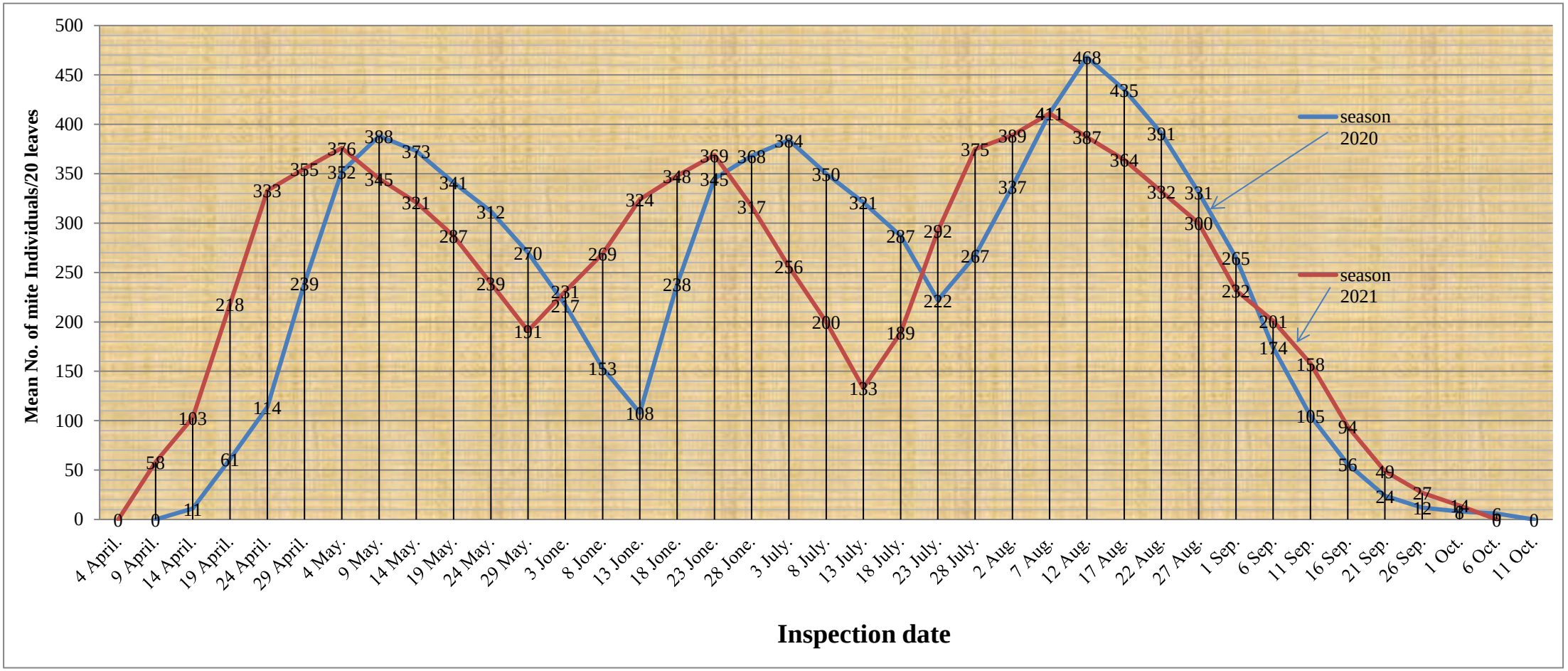


Fig. (1): Population Dynamics of European red mite *P. ulmi* on apple trees (mean No. /20 leaves) during seasons 2020-2021 (April - October)

Temperature was appropriate for the mite activity and they are around 30°C (Table 1). This means that this period were appropriate for the activity of *P. ulmi* on apple trees, again the presented results are in agreement of those reported by **Mohd Yaqoob Dar *et al*. (2018)**.

Table (1): Temperature (°C) recorded during the period of examination of two successive seasons of 2020 and 2021

Season	Temperature	Temperature (°C) during the season of 2020-2021						
		April	May	Jun	July	August	September	October
2020	Max. *	29.4	34.7	36.3	36.5	36.2	34.1	30.1
	Min.	13.1	19.3	20.4	21.6	21.4	20.2	17.1
	Med.	21.25	27.0	28.35	29.05	28.8	27.15	23.6
2021	Max. *	29.6	34.9	36.1	36.3	36.5	34.4	31.2
	Min.	13.3	18.8	20.6	21.4	21.9	20.6	17.4
	Med.	21.45	26.85	28.35	28.85	29.2	27.5	24.3

*Max. = Maximum temperature, Min. = Minimum temperature and Med. = Medium temperature.

Evaluation of certain pesticide against the European red mite *P. ulmi* (Koch) on apple trees during two successive seasons (2020 and 2021)

The first season 2020
The first spray

The mean number of alive mite individual/20 fixed and labeled leaves before and after the application of the tested agrochemicals and the reduction percentage of alive mite individuals after 3 applications of each treatments on three apple trees during two seasons of study are shown in (Fig. 2).

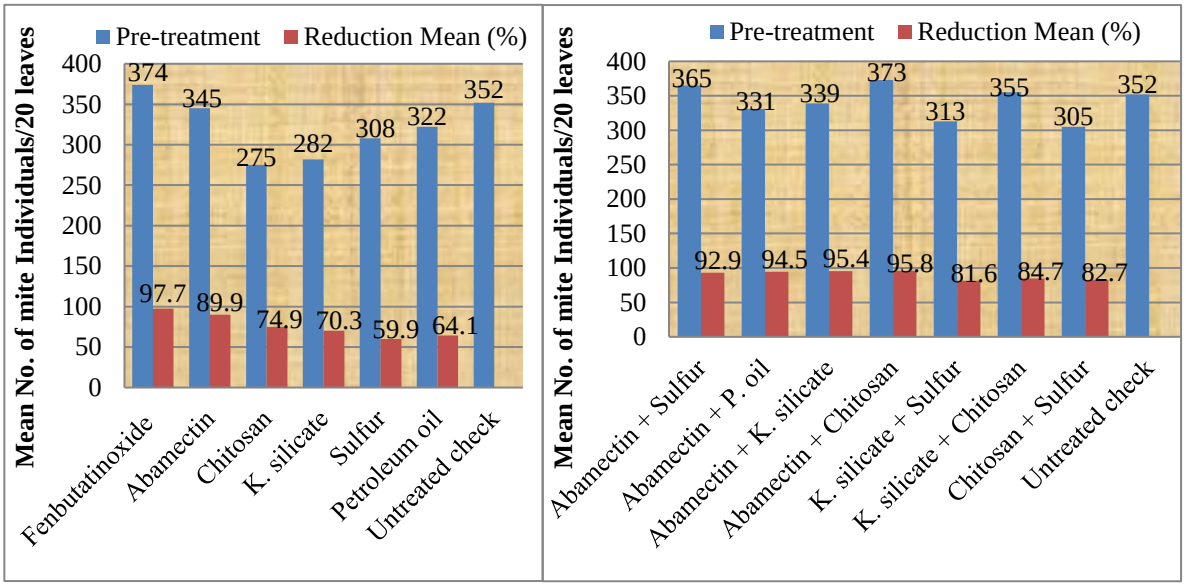


Fig. (2): Evaluation of certain agrochemicals and their mixtures against the European red mite individuals, *P. ulmi* (Koch) infesting apple trees

The statistical analysis showed for all tested agrochemicals efficiency against the *P. ulmi*, where compounds Fenbutatin-oxide and Abamectin were the most effective tested compounds showing reduction 97.7 and 89.9%, respectively. While come both two compounds P. oil and Sulfur showed the lower reduction percentage of 64.1 and 59.5%.

Mixtures (Abamectin with Chitosan) and (Abamectin with K. silicate) were the most effective tested mixtures showing higher reductions of 95.8 and 95.4%, respectively. While come both three mixtures (Chitosan with K. silicate), (Chitosan with Sulfur) and (K. silicate with Sulfur) showed the lower reduction percentage of 84.7, 82.7 and 81.6%, in respect, as compared with the other tested compounds and mixtures.

The statistical analysis showed certain differences between the running treatments concerning their effect on the number of the mite individuals infesting the tree leaves. For that the farmer can choose one from of these agrochemicals

or mixtures and the cheaper will be the best to reduce the costs of control.

The second spray

Fig. (3) presented the mean numbers of the *P. ulmi* individuals/20 leaves and the infestation reduction percentage of different evaluated treatments after the second spray during the study season 2020, where Fenbutatin-oxide was the most effective gave 97.9%, followed by Abamectin gave 90.2%, On the other hand, P. oil and Sulfur showed the lower reduction percentage of 64.8 and 60.1% in respect.

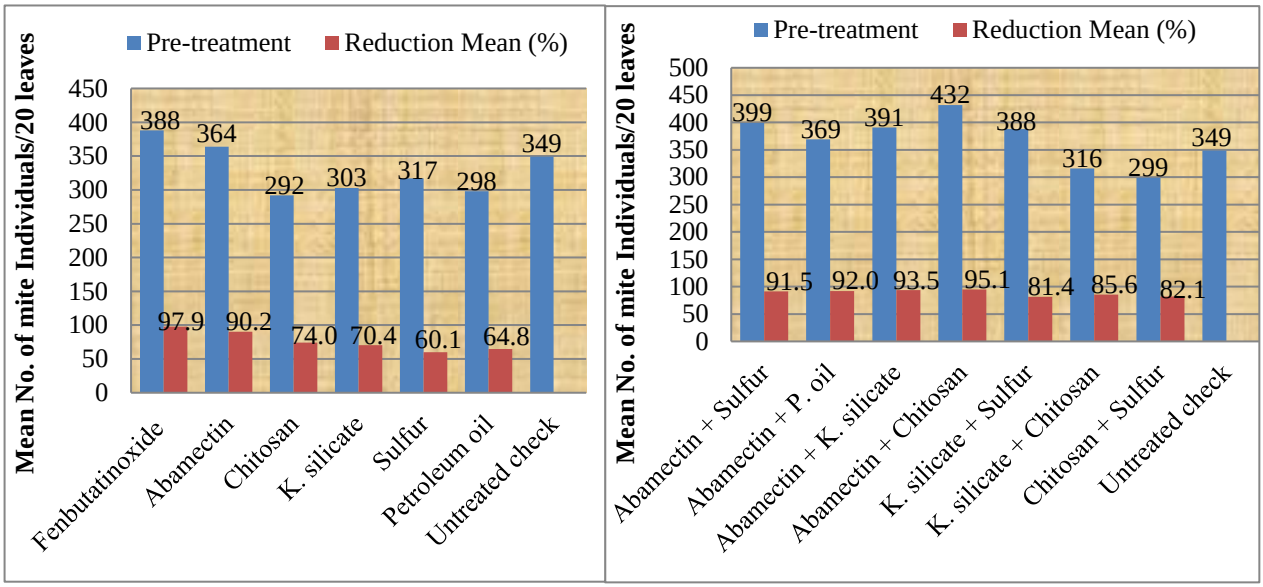


Fig. (3): Evaluation of certain agrochemicals and their mixtures against the European red mite individuals, *P. ulmi* (Koch) infesting apple trees

Mixtures more or less had a considerable effect against of the *P. ulmi* (Abamectin with Chitosan) was the most effective mixture showing the highest reduction of the mite calculated by 95.1%, while (Chitosan with Sulfur) and (K. silicate with Sulfur) showed the lower reduction percentage of 82.1 and 81.4% in respect, as compared with the other tested mixtures, no significant differences between them.

The third spray

Effect of the third spray treatments on *P. ulmi* shown in (Fig. 4) Fenbutatin-oxide recorded the highest of reduction percentage 97.5%, followed by Abamectin 90.7%, while come P. oil and Sulfur in last order where gave reduction percentage 65.0 and 61.1%.

Mixture (Abamectin with Chitosan) recorded the highest reduction percentage 95.3% followed by (Abamectin with K. silicate) 94.9%, mixtures (Chitosan with Sulfur) and (K. silicate with Sulfur) recorded the lower reduction percentage of 83.9 and 82.5.

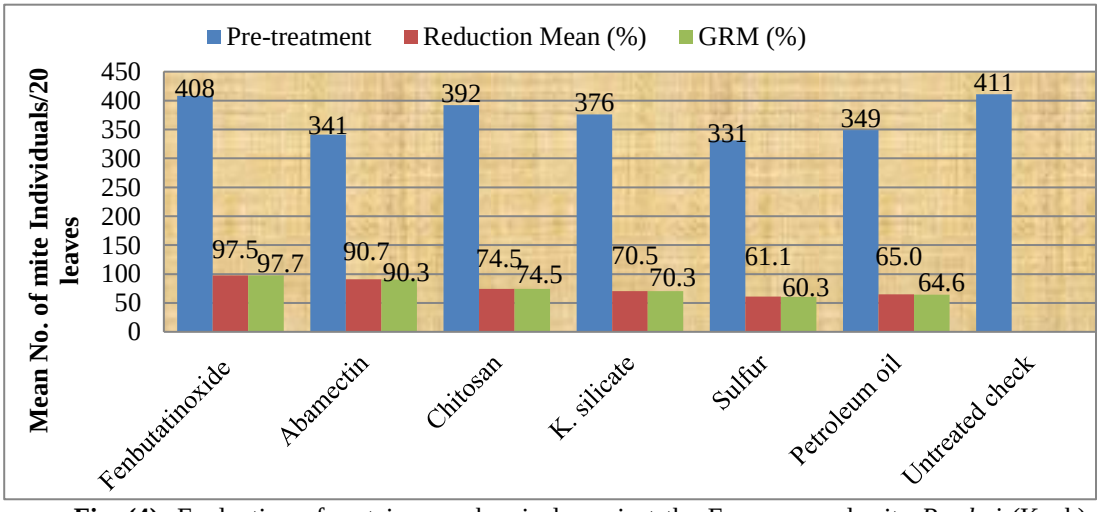


Fig. (4): Evaluation of certain agrochemicals against the European red mite *P. ulmi* (Koch) infesting apple trees

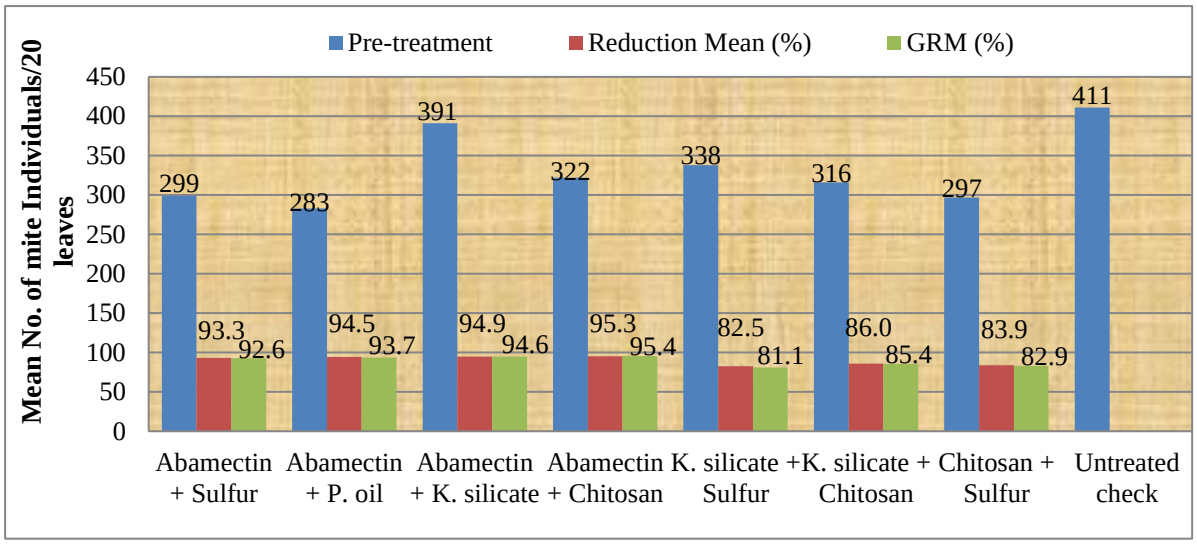


Fig. (5): Evaluation of mixtures against the European red mite *P. ulmi* infesting apple trees

Concerning the calculation of the general reduction mean (GRM) for 3 sequential applications of the tested agrochemicals during the first season of 2020 are presented and shown in (Fig. 4), it was obvious that Fenbutatin-oxide was the most effective evaluated compound giving the highest general mean of reduction of the mite individuals calculated by 97.7%, followed by Abamectin 90.3% in respect. Although both P. oil and sulfur showed their activity for reducing the individuals of the mite, they came in the last rank without significant differences between them and their recorded (GRM) were 64.6 and 60.3% in respect.

On the other hand the mixture (Abamectin with Chitosan) was the most effective evaluated mixture giving the highest general mean of reduction of the mite individuals 95.4% followed by the application of (Abamectin with K. silicate) 94.6% in respect. Although both (Chitosan with Sulfur) and (K. silicate with sulfur) showed their activity for reducing the individuals of the mite, they were the least effective mixtures as compared with the other tested mixtures and they came in the last rank without significant differences between them and their recorded (GRM) were 82.9 and 81.8% in respect.

The second season 2021

The first spray

During the season of 2021 three sprays on leaves were chosen from 4 branches located in the four directions around each tree. Showed (Fig. 6) for all the tested compounds efficiency against *P. ulmi* both compounds Fenbutatin-oxide and Abamectin were the most effective tested compound showing higher reductions of 97.1 and 90.0% in respect. as compared with the other tested compounds. While come both P. oil and Sulfur showed the lower reduction percentage of 64.3 and 61.0% in respect.

While showed that for all the tested mixtures, high efficiency against the *P. ulmi*, nevertheless, mixture (Abamectin with Chitosan) it the most effective tested mixture and have a high effect showing the higher mite reductions of 95.7%. Meanwhile (K. silicate with Sulfur) was the least effective tested mixture 80.9% as compared with the other evaluated mixtures.

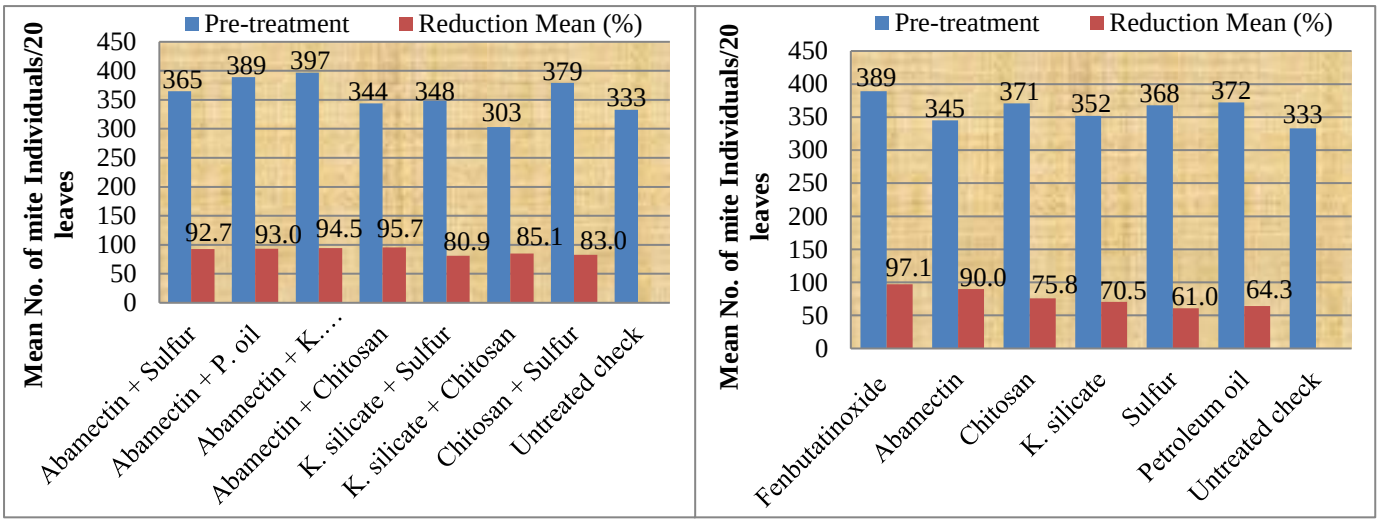
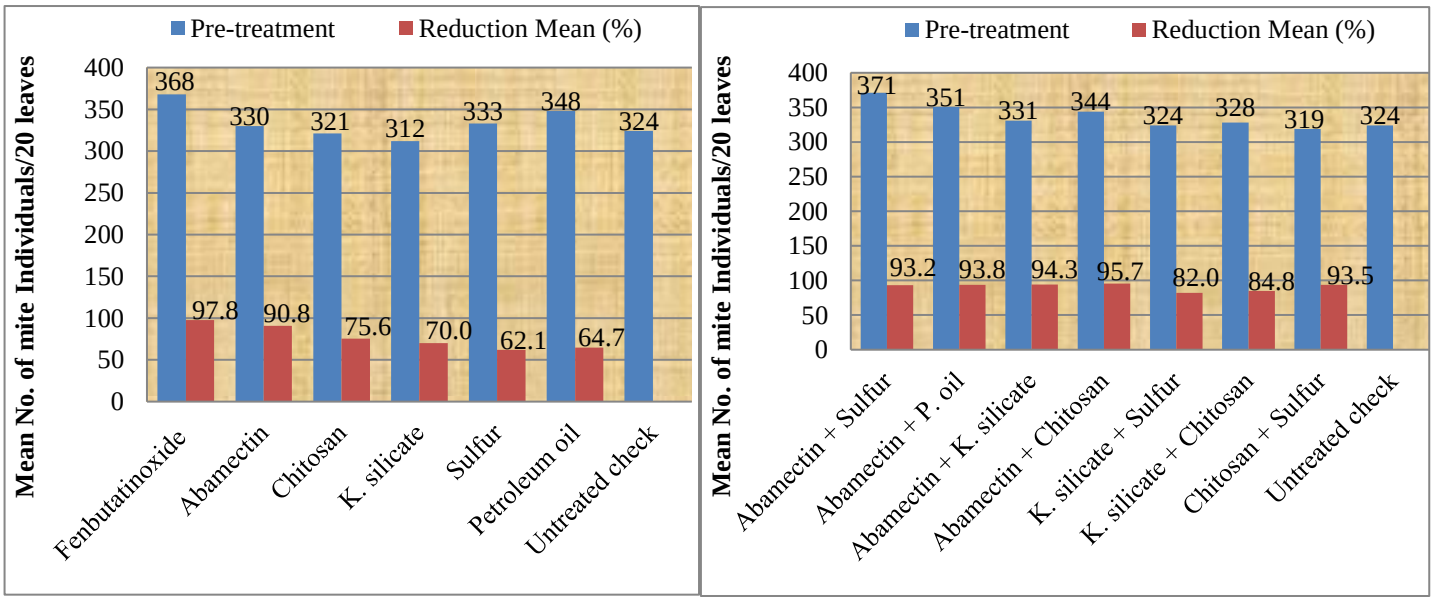


Fig. (6): Evaluation of certain agrochemicals and their mixtures against the European red mite individuals, *P. ulmi* (Koch) infesting apple trees

The second spray

Results presented in (Fig.7) showed that the effect of the second spray of different evaluated compounds against the *P. ulmi*. All the evaluated compounds showed a considerable effect. Two compounds Fenbutatin-oxide and Abamectin was the most effective compounds 97.8 and 90.8% respectively. While come both two compounds Petroleum oil and sulfur showed the lower reduction percentage of 64.7and 62.1% in respect. Generally, all the evaluated mixtures showed considerable effect, but mixtures (Abamectin with Chitosan) and (Abamectin with K. silicate) was the most effective mixtures 95.7 and 94.3% in respect. While come both two mixtures (Chitosan with Sulfur) and (K. silicate with Sulfur) showed the lower reduction percentage of 83.5 and 82.0% in respect, as compared with the other tested mixtures.



as compared with the other tested compounds.

Fig. (7): Evaluation of certain agrochemicals and their mixtures against the European red mite individuals, *P. ulmi* (Koch) infesting apple trees

The third spray

Fig. (8) showed that the third spray assured again that two compounds Fenbutatin-oxide and Abamectin was the most effective evaluated two compounds 99.0 and 90.5%, while compounds (P. oil and Sulfur) was the least effective 65.0 and 62.7% in respect. as compared with the other tested compounds, also assured again that mixture (Abamectin with Chitosan) was the most effective evaluated mixture 94.3%, while mixture (K. silicate with Sulfur) was the least effective 83.2% as compared with the other tested mixtures.

The calculation of GRM for 3 sprays is shown in (Fig. 8) two compounds Fenbutatin-oxide and Abamectin was proved for the second season the most effective, given the highest reduction of the *P. ulmi* individuals that detected on the leaves of apple trees calculated by 97.9 and 90.4% as compared with the other tested compounds, was followed by the compounds application of Chitosan, K. silicate, P. oil and Sulfur 75.9, 70.8, 65.0 and 62.7% in respect.

Mixture (Abamectin with Chitosan) was proved for the second season to be the most effective evaluated mixture where gave the highest reduction of the *P. ulmi* individuals that detected on the leaves of apple trees calculated by 95.2% as compared with the other tested mixtures, was followed by the application of (Abamectin with K. silicate), (Abamectin with P. oil), and (Abamectin with Sulfur) (94.1, 93.2 and 92.8% in respect). While come mixtures (Chitosan with K. silicate), (Chitosan with Sulfur) and (K. silicate with Sulfur) showed the lower reduction percentage of 84.8, 83.5 and 82.0% in respect, as compared with the other tested mixtures.

The results showed that all compounds and mixtures have a good effect against the *P. ulmi* and can be used depending on their coast. The statistical analysis showed certain differences between the running treatments concerning their effect on *P. ulmi*, could be considered as an effective acaricide in the IPM programs.

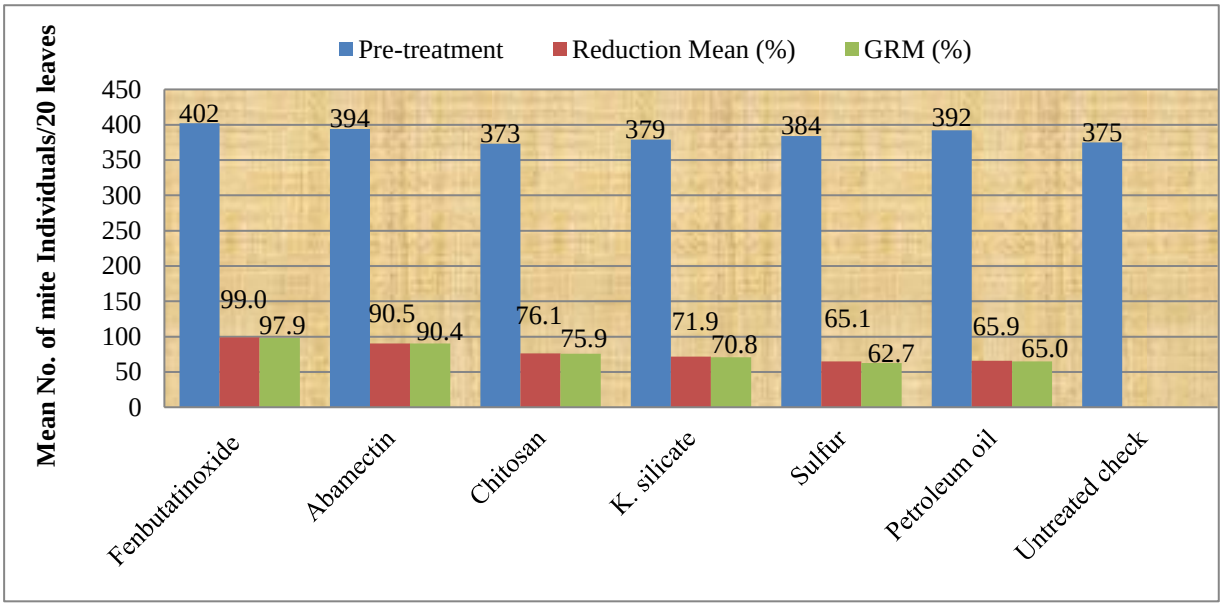


Fig. (8): Evaluation of certain agrochemicals against the European red mite individuals, *P. ulmi* (Koch) infesting apple trees

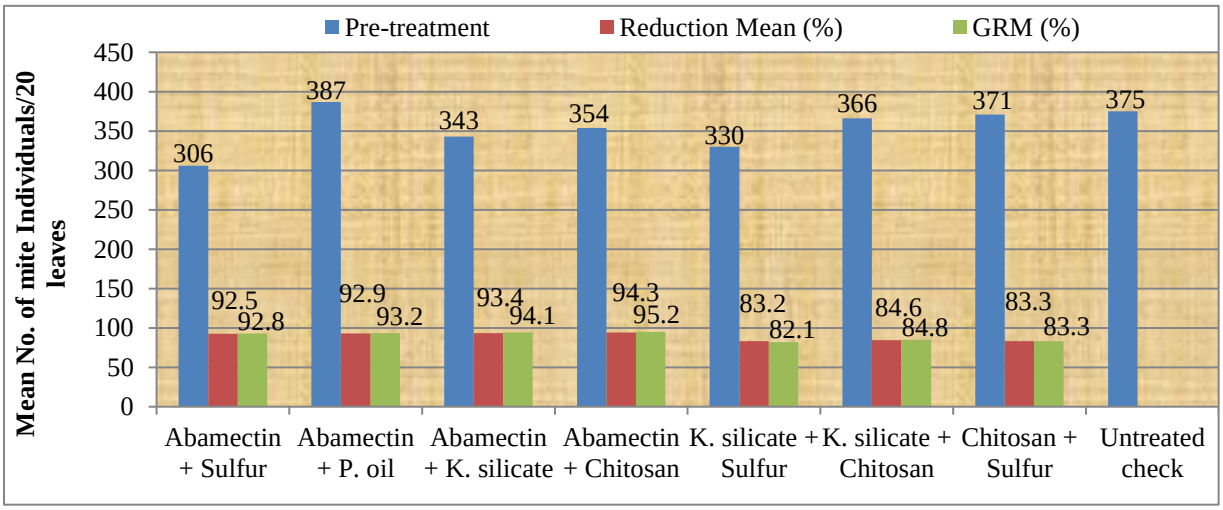


Fig. (9): Evaluation of mixtures against the European red mite individuals, *P. ulmi* (Koch) infesting apple trees

The results have been obtained in our study is supported by those published by (**Agnello *et al.*, 2020)**, and can be used as tools in (IPM) programs to replace conventional acaricides **(Pree *et al.*, 2000).**

When they evaluated the efficacy of many form Abamectin and other compounds against *P. ulmi*, in the integrated pest management (IPM) programs **(Said O. *et al.*, 2020)**.

Meanwhile, found the application of silicon is provides a viable component of integrated management of insect pests and diseases because there is no pesticide residues in food or the environment **(Laing M. D *et al.*, 2006).**

Also when evaluated the efficacy of Chitosan against of *P. ulmi* gave a good results (**Hala H. A. 2020).**

In experiment during two successive seasons concluded that all compounds Fenbutatin-oxide, Abamectin, Chitosan, K. silicate, P. oil, Sulfur and all mixtures, were effective against of *P. ulmi*.

Furthermore, all mixtures and agrochemicals were the less harmful affect against the beneficial predatory mite, Therefore, all compounds can playing a big role for controlling of *P. ulmi*, and conserving the beneficial non-targeted organism if it was used within an IPM program for controlling apple trees pests.

From results during two study seasons, we recommend by using these mixtures and agrochemicals in (IPM) programs for control *P. ulmi* and other mites infecting apples. Also to obtain a safe healthy production and increase the obtain to presented a good foods and conservative on health of individual and society.

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الملخص العـربـــي

الإتجاهات الحديثة لمكافحة العنكبوت الأحمر الأوروبي المتعلقة بحركية العشيرة على أشجار التفاح

عبدالفتاح سيد عبدالكريم سعد، مجدي عبد الظاهر مسعود، أحمد محمد علي كردي, محمد محروس الشاذلي،
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لقد تمت دراسة التذبذب العشائري ومكافحة العنكبوت الأحمر الأوروبي برش مركبات مختلفة وخلائطها علي أشجار التفاح صنف (أنا) بمنطقة أبو المطامير– البحيرة خلال موسمي الدراسة (2020 ، 2021). ولوحظ أن حركية عشيرة العنكبوت تتأثر بالعديد من العوامل. وفي الموسم الأول (2020) كان أول ظهور للعنكبوت في 14 أبريل و إختفى في 11 أكتوبر ، كما لوحظ وجود 3 فترات ذروة تتزايد فيها أعداد العنكبوت زيادة كبيرة (حدوث قمة) في موسم 2020، وقد تم تسجيل فترة الذروة الأولي في منتصف مايو والثانية في نهاية شهر يونيو أما الثالثة سجلت في منتصف شهر أغسطس تقريباً ، وفي موسم 2021 أول ظهور للعنكبوت سُجل في 13 أبريل تقريباً وإختفى في 5 أكتوبر تقريباً ، ولوحظ أيضاً 3 فترات ذروة تتزايد فيها أعداد (فترة الذروة) الأولي تم تسجيلها في بداية الإسبوع الثاني من مايو والثانية في الأسبوع الأخير من يونيو، أما الثالثة كانت في الأسبوع الثاني من شهر أغسطس. وقد اعتمدت الإصابة وشدتها بالعنكبوت علي درجة الحرارة السائدة في المنطقة وزيادتها عن 30° مئوية في موسمي الدراسة. كما تم تقييم كفاءة ستة مركبات (فنبيوتاتين أكسيد، أبامكتين ، شيتوزان ، سليكاتالبوتاسيوم ، الزيت البترولي, كبريت) حيث طبقت هذه المركبات بالجرعة المجربة حقلياً والموصي بها من قبل وزارة الزراعة المصرية, وتم حساب متوسط الخفض بعد كل رشة خلال موسمي الدراسة. وأظهرت النتائج أن لكل المركبات المستخدمة والمجربة حقلياً نتائج مرضية بالنسبة للمزارع المصري, وفي كلا الموسمين جاء فنبيوتاتين أكسيد في المقدمة حيث حقق أعلى كفاءة وأعطى متوسط نسبة خفض مرضية للرشات الثلاثة قدرت بـ 97,7%. يليه مركب أبامكتين 90,3%. في موسم (2020) كبديل فنبيوتاتين أكسيد, بينما كان هذا المتوسط أيضاً 97,9 , 90,4% في عام (2021). في نفس الوقت أظهرت النتائج أن مركبات الزيت البترولي، كبريت كانت أقل المركبات المختبرة كفاءة ولكن لم تقل عن 60,3% ,62,7% على التوالي في موسمي الدراسة. كما تم تقييم كفاءة سبعة خلائط لهذهالمركبات وطبقت خلائط أبامكتين 1/2 الجرعة , كبريت 3/4 الجرعة , وباقي المركبات بالجرعة الكاملةوالمجربة حقلياً والموصي بها من قبل وزارة الزراعة المصرية. وأظهرت النتائج أن لكل الخلائط المستخدمة والمجربة حقلياً نتائج مرضية بالنسبة للمزارع, وأظهرت النتائج أن خلائط أبامكتين مع المركبات الأخرى (أبامكتين + شيتوزان) , (أبامكتين + سليكات البوتاسيوم) , (أبامكتين + كبريت) , (أبامكتين + زيت بترولي) كانت أكثر الخلائط المختبرة كفاءة وأعطت أعلي متوسط خفض عام قدر بـ 95,4 , 94,6 , 92,6 , 93,7 % علي التوالي في موسم (2020) , بينما كان هذا المتوسط أيضاً 95,2 , 94,1 , 92,8 , 93,2 % في موسم (2021). في نفس الوقت أظهرت النتائج أن مخاليط (سليكات البوتاسيوم + كبريت) , (شيتوزان + سليكات البوتاسيوم) , (شيتوزان + كبريت) كانت أقل الخلائط المختبرة كفاءة ومع هذا كان متوسط نسب الخفض لهذه الخلائط لم يقل عن 81,8 % في موسم (2020) وكذلك 82,1 % في موسم (2021). ومن خلال النتائج الحقلية المتحصل عليها فعلياً خلال موسمي الدراسة نوصي بإستخدام هذه المركبات في برامج المكافحة المتكاملة للعنكبوت الأحمر الأوروبي وغيره من العناكب التي تصيب التفاح وغيره من الزراعات لخفض الإصابة بهذه الآفه وكذلك الحصول على إنتاج آمن , صحي , وفير لتقليل الواردات من الخارج والحفاظ على صحة الفرد والمجتمع.