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EFFICIENCY OF SOME CONTROL AGENTS AGAINST NOSEMA DISEASE (*NOSEMA APIS* ZANDER) INFECTING HONEYBEE COLONIES (*APIS MELLIFERA* L.)

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ABSTRACT: A detailed study was carried to evaluate the efficiency of metronidazole, wormwood (*Artimisia cinae* Willkomm) and wormwood + thyme (*Thymuo vulgaris* L.) extracts (1: 1 wt/wt), offered in sugar syrup, in repressing the development of *Nosema* disease infecting honeybee colonies during two period February 2002 and 2003. The subsequent effects on worker brood rearing activity, development of workers body weight and honey production of treated colonies were also studied. Obtained results could be summarized as follow:

Wormwood + thyme extract induced noticeable reduction in the rate of *Nosema* infection, attaining 74.96, 71.34% after 4 weeks from treatment in 2002 and 2003, respectivly, followed by metronidazole, recoding 71.13 and 64.55% reduction, meanwhile wormwood extract only caused 68.75 and 58.79% reduction in the rate of *Nosema* infection in both seasons, respectively.

***Nosema* infected nurse workers possessed the heaviest body weight. The heaviest body weight in general was recorded for 14 days old workers, recording (108.6, 110.1 mg/healthy worker, and 133.4, 135.9 mg/ infected worker in 2002 and 2003, respectively. Wokers of treated colonies were intermediate.**

Infected colonies showed 50.9 and 54.8% reduction in workers brood rearing activity compared to that of healthy colonies. Treating the infected colonies with metronidazole, wormwood and wormwood + thyme extracts improved brood rearing activity, recording reduction rates of 17.8, 11.6 and 5.7%, in 2002; 19.3, 16.1 and 14.5% in 2003 season for the three treatments, respectively.

The two years mean total honey yield produced by the test colonies were 7.71, 2.28, 4.92, 3.38 and 4.60kg/colony for healthy, *Nosema* infected (untreated), treated colonies with metronidazole, wormwood and wormwood + thyme extracts, respectively.

It is recommended to avoid *Nosema* infection to honeybee colonies to prevent the losses by applying all the possible prophyliactic measures. However, in case of infected colonies the treatment with the extract of wormwood + thyme was safe and useful in respressing the disease and reducing the losses.

Key words: Nosema, *Apis mellifera*, wormwood, brood, metronidazole, thyme, clover honey.

INTRODUCTION

Nosema disease is the most widely spread and economically the most serious disease of honeybee allover the world. The damage caused by *Nosema* must not be measured only by colony mortality, but by the symptoms of reduction in biological and productivity parameters of an individual bee and the bee colony as a wlole (Kauffeld *et al.*, 1972). These problems collectively cause losses that equal or exceed those caused by all of the other bee diseases, including the more easily diagnosed larval diseases. (Furgala and Mussen, 1978). Therefore, the weapons beekeepers use to combat *Nosema* disease have changed over the years (Gochnauer *et al.*, 1975).

Nosema diseased bees show disorders in their digestion, secretion and absorbsion processes because the epithelial cells of their midgut are damaged. Subsequently, biochemical composition of the bees body changes, leading to weakened enzymatic activities, negative nitrogen balance, reduced biological activities and shortened lives of diseased bees (Zherebkin, 1977).Therefore, great attention was paid to prevent the infection properly and control the infected colonies to reduce the expected losses.

Many control agents were used, however residues of some agents were detected in bee wax and other hive products. Therefore, the need for alternative safe control agents became greater to prevent the contamination of the hive products. In addition, *Nosema apis* may show signs of resistance to such chemicals (Gross and Ruttner, 1970).

The aim of the present work is to evaluate the efficiency of two plant extracts as control agents

(wormwood and wormwood + thyme) compared to the standard drug recommended (metronidazole). The effects of such treatments on some biological, and productivity parameters of the treated honey bee colonies were also taken in consideration

MATERIALS AND METHODS

Materials

Test Honeybee Colonies

Fifteen honeybee colonies headed by sister F_1 Carniolan queens, nearly equal in strength were divided randomly in to five groups of 3 colonies (replicates) each as follow:

Group 1 consisted of healthy colonies that used as control.

Group 2: consisted of untreated *Nosema*-artificially infected colonies.

Group 3 consisted of *Nosema* artificially infected colonies and treated with metronidazole [Elyzole (Antiprotozoal and antibacterial agent, formulated as suspension, each 5 ml contain 125 mg metronidazole benzoate] at the rate of 2.5 ml / colony 4 times at 7 day intervals.

Groups 4 and 5 consisted of *Nosema* artificially infected colonies and treated with the extracts of wormwood herbs solely and mixed with thyme plants (1:1 wt/wt) , respectively.

Preparation of Plant Extracts

The wormwood and thyme extraction was made by boiling 250 gm of flowers and leaves of wormwood and 250 gm thyme in 1.5 litres water for 15 minutes. After filtration, the extract (one litre) was added to 50 litres of sugar syrup 1:1. This mixture was offered to hundred colonies, each to contain the extract of 5 mg. of flowers and leaves wormwood and thyme/colony according to (El-Shemy *et al.*, 1990) four times at 7 day intervals during February 2002 and 2003.

Methods

Assessing the Rate of *Nosema* Infection

Samples of 10 bees each were picked up randomly from each colony. The midgut and rectum of each bee were dissected out and examined collectively for *Nosema* infection. Bees of each sample were put into a small vial containing 1 ml of Nigrosine solution (0.5 gm stain in litre of distilled water) (Pickard and El-Shemy, 1989). The dissected organs were scraped and washed off into the solution with the aid of a small glass rod to become homogenize. One drop of this solution was placed on slide and examined under a microscope at X40 magnification (Cantwell, 1970).

The percentage of infection was calculated according to the following equation.

$$\text{Infection percentage of honey bee colonies} = \frac{\text{No. of infected colonies}}{\text{Total No. of examined colonies}} \times 100$$

Percent *Nosema* infection to the test honey bee colonies was assessed twice; the first was performed during February and before applying any control treatments, while the second was carried out after one month from the onset of the control treatments. Thereafter, percent reduction in the rate of *Nosema* infection was calculated according to Henderson and Tilton (1955) formula:

$$\% \text{ Reduction} = 1 - \frac{\% \text{ infection after treat}}{\% \text{ infection before treat.}} \times \frac{\% \text{ infection in the control after}}{\% \text{ infection in the control before}} \times 100$$

The effects of the test treatments on some activities of honeybee colonies involving development of workers body weight, brood rearing activity and honey production were assessed as follow:

Assessing the Development of Workers Body Weight

Sealed brood comb up to emerge was taken from each experimental colony, then the bees covering it were discarded by bee brush. Thereafter, the comb was caged in the so called complete comb cage that used in queen's introduction and placed quickly in the middle of brood nest in the original colony. After 12 hours the cage was taken out and over 150 newly emerged workers were marked on the thorax with colour paint to be easily recognized latter, then they were released immediately in their colony with smoking to reduce the bees attack. Thereafter, samples of 25 marked workers of newly emerged, 7, 14 and 21 days old were picked up from each colony. The collected bees were slightly anaesthetized by chilling then they were quickly weighed individually. This study was performed during March 2002 and 2003.

Evaluating Brood Rearing Activity

The areas of workers sealed brood cells present in the colonies of the five groups were measured separately at twelve-day intervals starting from March, 21 to September 19, in 2002 and 2003. The measurements were made using Hoffman frame divided into square inches according to El-Shakaa (1985). Bees covering brood comb were firstly shaken off then the area of sealed brood was measured at both sides of the comb. Thereafter, the comb was

returned back to its site in the original colony.

Estimating Honey Production

Clover honey yield

Clover flow started at the beginning of May and lasted to the second week of June when the honey yield was estimated for each experimental colony of healthy, *Nosema* infected, and treated workers with metronidazole, wormwood and wormwood +thyme extracts. The surplus honey combs were taken from their respective colonies and marked with paint colour after the bees covering were shaken off. Honey yield was estimated for each colony separately (in kg/colony) by calculating the difference between the weight of honey combs before and after extraction of honey. The extracted combs were then returned back to their respective colonies.

Cotton honey yield

Cotton flow started at the beginning of summer season (4^{th} week of June) and lasted to the second half of August when the honey yield was estimated for each experimental colony of healthy, *Nosema* infected (untreated), and treated colonies with meteronidazole, wormwood and wormwood + thyme extracts as described above.

Data obtained were statistically analysed according to Snedecor's (1957) methods.

RESULTS AND DISCUSSION

Efficiency of Some Control Agents Against Nosema Infection

Pre-treatment rate of nosema infection

The rate of *Nosema* infection before applying any treatment recorded 28.42, 41.33, 26.73 and 32.21% in 2002; 43.67, 37.67, 46.67 and 51.33% in 2003 for the tested colonies artificially infected (untreated) and those treated with metronidazole, wormwood and wormwood + thyme extracts, respectively (Table 1)

Post-treatment rate of Nosema infection

As shown in Table 1, the percentage of *Nosema* infection in the treated colonies after four applications with the test agents decrease to 62.72, 26.33, 18.43 and 17.18% in 2002; 64.33, 19.62, 28.33 and 21.67% in 2003 for infected (untreated) treated colonies with the during metronidazole, the extracts of wormwood and wormwood + thyme, respectively.

Table 1. Effect of tested materials on percentage of *nosema* infection of honeybee colonies during Feburary 2002 and 2003 (The treatments were done 4 times at weekly intervals)

Treatments \ Year	2002			2003		
	% infection Pre-treatment	% infection Post-treatment (4 weeks)	% reduction of infection	% infection Pre-treatment	% infection Post-treatment (4 weeks)	% reduction of infection
Infected colonies	28.42	62.72	-	43.67	64.33	-
Metronidazole	41.33	26.33	71.13	37.67	19.62	64.55
Wormwood extract	26.73	18.43	68.75	46.67	28.33	58.79
Wormwood + thyme extract (1:1 wt./wt.)	32.21	17.81	74.96	51.33	21.67	71.34

Rate of reduction in nosema % infection

Data presented in Table 1, clear that treating artificially infected honeybee colonies 4 times at 7- day intervals with metronidazole, wormwood and wormwood + thyme extracts, respectively caused noticeable reduction in the rate of infection, recording 71.13, 68.75 and 74.96 % in 2002; 64.55, 58.79 and 71.34% reduction in 2003 for the tested colonies, respectively.

In this concern, El-Shemy *et al.* (1990), basing on the results of an experiment achieved in spring to control *Nosema* disease in honey bee colonies using the extract of wormwood reported that this extract could be of promise for controlling this disease, and satisfactory results could be achieved by repeated treatments throughout the season of infection- Moreover, Abou-Lila *et al.* (1999) realized effective control of *Nosema* using three formulations of metronidazole as well as some preservatives.

The Development of Workers Body Weight

The weight of newly emerged workers, as well as those of 7,14, and 21 days old was recorded for healthy, *Nosema* infected and treated colonies with metronidazole, wormwood and wormwood + thyme extracts during 2002 and 2003 seasons. Obtained results are presented in Table 2.

Newly emerged workers

As shown in Table 2, the average weight of newly emerged workers recorded 93.7, 94.8, 92.8, 93.6 and 94.4 mg/bee, in 2002; 91.8, 92.7, 92.2, 93.0 and 92.1 mg/bee for healthy, *Nosema* infected and treated colonies with metronidazole, wormwood and wormwood + thyme extracts in 2003, respectively. The differences between treatments during the two years are insignificant.

Seven days old workers

The mean body weight of 7-days old workers attained 101.3, 112.5, 107.0, 106.1 and 104.1 mg/bee in 2002; 105.2, 123.6, 112.3, 115.4 and 108.5 mg/bee, in 2003 season for healthy, *Nosema* infected (untreated) and treated colonies with metronidazole, wormwood and wormwood + thyme extracts, respectively. Analysis of variance revealed significant difference between the means during the 2 years of study. Generally, the least significant weight of 7 days old workers was

Table 2. Effect of nosema infection and tested materials on workers body weight (mg) during March, 2002 and 2003.

Year	2002				2003			
Workers age (days) / Treatments	Averag weight (mg)							
	Newly emerged	7	14	21	Newly emerged	7	14	21
Healthy colonies	93.7	101.3	108.6	95.8	91.8	105.2	110.1	98.7
Infected colonies	94.8	112.5	133.4	136.1	92.7	123.6	135.9	133.1
Metronidazole	92.8	107.0	121.4	122.5	92.2	112.3	120.4	110.9
Wormwood extract	93.6	106.1	124.3	123.2	93.0	115.4	124.2	114.4
Wormwood + thyme extract (1:1)	94.4	104.1	116.8	115.7	92.1	108.5	116.2	106.8
LSD 0.05	NS	1.38	3.05	4.91	NS	2.35	3.22	4.25
LSD 0.01		1.84	4.06	6.55		3.13	4.29	5.66

recorded for healthy workers. On the contrary, the highest significant weight was detected for infected (untreated) workers in both seasons.

Fourteen days old workers

Obtained results cleared that the mean weight of 14-days old workers attained 108.6, 133.4, 121.4, 124.3 and 116.8 mg / bee, in 2002; 110.1, 135.9, 120.4, 124.2 and 116.2 mg/ bee, in 2003 for healthy, infected (untreated), and treated colonies with metronidazole, wormwood and wormwood + thyme extracts, respectively. Statistical analysis indicated that the lightest significant weight of 14- days old workers was recorded for healthy workers, while the heaviest weight was recorded for infected (untreated) workers. Treated workers with the tested antiprotozoal agents were intermediates (Table 2).

Twenty-one days old workers

Data presented in Table 2 showed that the mean weight of 21-days old workers was 95.8, 136.1, 122.5, 123.2 and115.7 mg, in 2002; 98.7, 133.1, 110.9, 114.4 and 106.8 mg, in 2003 season for healthy, *Nosema* infected (untreated) and treated workers with metronidazole, wormwood extract and wormwood + thyme extract, respectively. Analysis of variance revealed significant differences between the means of the treatments in both seasons.

Discussing the data concerning body weight of honey bee workers as affected by the infection with *Nosema* disease and the efficiency of some control agents in this respect revealed the following:

- The lightest workers body weight was recorded for newly emerged workers. Thereafter, the weight increased until recording the heaviest between the 14-21 days of workers age. These finding are in partial accordance with those of El-Shakaa (1985) and Abd - Alla (1999).
- Infected (untreated) workers possessed the heaviest body weight at all ages tested and this is due to the filling of stomach and rectum with freshly swallen pollen and liquids full of *Nosema* spores. In connection, Zherebkin (1977) found that *Nosema* diseased bees eat more pollen, in the first days after infection, bees consumed about 1.5 times more pollen than the healthy ones. Even the midgut of sick

23-25 days old bees was full of freshly swallowed pollen while that of healthy bees was empty.

Brood Rearing Activity

Data presented in Tables 3 and 4 clear that there are three peaks of brood rearing activity in both seasons, however the period of the three peaks was different , i.e the first peak was detected during the first half of April in both seasons. Meanwhile, the second peak took place during the first half of June in 2002 and during the second half of June, in 2003. The third peak was taken place during the first week of September 2002. On the other hand, this peak took place during the first half of August 2003. This variation in the period of the 2nd and 3rd peaks could be attributed to the availability of maize pollen, the vicinity and probable to weather factors. Generally, the first peak is coincided with the top flowering of citrus trees and winter crops other than Egyptian clover whose blooming is coincided with the second peak of brood rearing activity. The third peak of sealed brood area is coincided with the top flowering of cotton plants (nectar source) and maize (main pollen source) during summer, in Egypt.

In connection, Abd- Alla (1997) and Hassan (1998) reported 3 peaks of sealed brood area during the active season in Egypt, to be coincided with the flowering of citrus, clover, cotton and maize, respectively.

In addition, data obtained cleared that infecting honey bee colonies with *Nosema* disease during fall and early spring resulted in serious reduction in brood rearing activity, reaching 50.9 and 54.8 % decrease in sealed brood area in diseased colonies as compared to that of the healthy ones in 2002 and 2003, respectively. However, treating the diseased colonies reduced greatly the adverse effect of the disease on this activity, as the reduction in the sealed brood area attained (17.8, 19.3%), (11.6, 16.1%) and (5.7, 14.5%) in the treated colonies with metronidazole, wormwood and wormwood + thyme extracts as compared to that of healthy colonies in 2002 and 2003 seasons, respectively.

The findings of Anderson and Giacon (1992) and Manning (1993) supported obtained results, as they agreed that the *Nosema* infection affected badly brood and adult bee populations. Moreover,

Table 3, Effect of *Nosema* infection and tested materials on brood rearing activity during 2002.

Date / Treatments	Sealed brood area (inch²/colony)																Tatal	Mean	% Reduc. of brood area
	21/3	2/4	14/4	26/4	8/5	20/5	3/6	15/6	27/6	9/7	21/7	2/8	14/8	26/8	7/9	19/9			
Healthy colonies	241.3	211.6	198.6	170.3	270.6	227.6	242.6	291.6	201.3	187.6	203.6	197.6	230.3	214.0	245.3	208.3	3536.3	221.0	-
Infected colonies	120.8	101.6	109.6	119.6	110.3	98.3	82.3	112.3	107.6	102.6	118.3	132.	92.6	96.3	117.3	98.3	1733.3	108.3	50.9
Metronidazole	192.3	217.3	223.6	165.6	209.0	227.6	216.0	235.6	180.6	168.6	183.0	191.3	203.3	178.0	209.0	142.0	3115.4	194.7	11.9
Wormwood extract	180.3	194.6	202.6	167.0	213.6	198.3	181.6	199.6	175.6	162.6	178.3	183.3	191.3	186.0	188.0	163.6	2919.7	182.5	17.4
Wormwood + thyme (1: 1)	201.3	236.6	238.3	172.6	236.3	243.6	226.0	254.0	195.6	175.0	193.6	210.3	220.3	218.6	226.0	185.0	3387.8	211.7	4.2
Mean	187.0	192.6	194.4	159.0	207.9	198.9	189.5	218.6	172.0	159.2	175.3	183.0	187.5	186.2	197.1	159.4			
LSD 0.05																		32. 35	
LSD 0.01																		41.77	

Table 4. Effect of *Nosema* infection and tested materials on brood rearing activity during 2003.

Date / Treatments	Sealed brood area (inch²/colony)																Tatal	Mean	% Reduc. of brood area
	21/3	2/4	14/4	26/4	8/5	20/5	3/6	15/6	27/6	9/7	21/7	2/8	14/8	26/8	7/9	19/9			
Healthy colonies	261.0	274.3	247.6	238.6	270.6	239.6	261.6	285.3	224.6	219.6	223.0	241.0	236.3	197.6	235.6	228.6	3381.9	242.6	-
Infected colonies	97.6	101.3	92.6	95.6	110.3	105.3	117.6	120.6	127.3	102.3	99.3	118.6	121.6	183.6	122.6	116.3	1751.9	109.4	54.8
Metronidazole	187.3	189.3	210.6	201.6	209.0	192.6	203.6	215.6	216.3	200.6	207.6	213.6	218.6	186.0	210.3	194.3	3256.0	203.5	16.1
Wormwood extract	175.3	192.3	202.6	194.3	213.6	196.3	207.6	221.3	204.6	194.6	197.0	181.6	187.0	179.3	197.6	185.3	3130.3	195.6	19.3
Wormwood + thyme (1:1)	231.6	241.0	217.3	214.0	6.3	224.6	232.3	242.6	219.3	202.6	217.3	230.3	225.0	190.0	215.3	218.0	3320.0	207.5	14.5
Mean	181.5	199.6	194.1	188.2	207.9	191.6	204.4	216.9	198.4	183.9	188.8	197.0	197.8	171.3	196.2	188.5			
LSD 0.05																		35.63	
LSD 0.01																		47.21	

Wilde (1996) and Abou-Lila *et al.* (1999) stated that treating *Nosema* – infected honey bee colonies with fumagillin (the former) and metronidazole and some preservatives (the latters) improved the development and productivity of such colonies.

Honey Production

Clover honey yield

Data presented in Table 5 indicated that the clover honey yield gained from healthy, *Nosema* infected (untreated) and treated honey bee colonies with metronidazole, wormwood and wormwood + thyme extracts recorded 4.92, 1.38, 2.80, 2.05 and 3.03 kg / colony, in 2002; 5.26, 1.82, 3.80, 2.60 and 3.47 kg/ colony, in 2003, respectively. Analysis of variance revealed that healthy colonies produced the highest significant clover honey yield, wherease sick colonies produced the least one. Treating sick colonies with the tested antiprotozoal agents increased significantly clover honey yield, especially with wormwood + thyme extract and metronidazole. Generally, wormwood extract alone proved to be the least potent control agent.

Cotton honey yield

Obtained results indicated that the cotton honey yield produced by the tested honey bee colonies reached 2.70, 0.53, 1.60, 1.10 and 1.32 kg/colony, in 2002; 2.55, 0.83, 1.02 and 1.38 kg/ colony in 2003 season for healthy, infected treated colonies with metronidazole, wormwood extract and wormwood + thyme extracts, respectively. (Table 5).

Total honey yield

The total honey yield produced by the tested colonies recorded 7.620, 1.91, 4.40, 3.15 and 4.35 kg/ colony in 2002; 7.81, 2.65, 5.45, 3.62 and 4.85 kg/colony; in 2003 for healthy, *Nosema* infected, treated colonies with metronidzole, wormwood and wormwood + thyme extracts, respectively. The reduction in honey yield of *Nosema* infected colonies and those infected and treated with metronidazole, wormwood and wormwood + thyme extracts as compared to the honey yield of healthy colonies recorded 74.90, 42.20, 58.60 and 42.80 %, in 2002; 66.10, 30.20, 53.70 and 37.90%, in 2003, respectively (Table 5).

Finally, it could be concluded that *Nosema* infection to honeybee colonies has its harmful effect on the development and productivity of the colonies (workers body weight, brood rearing activity and

Table 5. Effect of nosema infection and tested materials on honey production (kg/colony) during 2002 and 2003.

Treatment	2002				2003				Two years mean	
	Honey yield (kg/colony)				Honey yield (kg / colony)					
	Clover honey	Cotton honey	Total honey yield	% Reduction of production	Clover honey	Cotton honey	Total honey yield	% Reduction of production.	Yield	% Reduction
Healthy colonies	4.92	2.70	7.62	-	5.26	2.55	7.81	-	7.71	-
Infected colonies	1.38	0.53	1.91	74.90	1.82	0.83	2.65	66.10	2.28	70.40
Metronidazole	2.80	1.60	4.40	42.20	3.80	1.65	5.45	30.20	4.92	36.20
Wormwood extract	2.05	1.10	3.15	58.60	2.60	1.02	3.62	53.70	3.38	56.20
Wormwood + thyme (1:1)	3.03	1.32	4.35	42.80	3.47	1.38	4.85	37.90	4.60	40.30
LSD 0.05	1.03	0.89			1.14	0.63				
LSD 0.01	1.57	1.22			2.31	0.92				

honey production). Similar reports were also reported by Liu (1992), Anderson and Giacon (1992) , Dag *et al.* (1996).

Treating the infected colonies with the tested drug (metronidazole) and plant extracts (wormwood) and wormwood + thyme) induced significant positive effect on percentage of reduction in *Nosema* infection, as well as the other tested parameters.

Some researchers reported that treating *Nosema* infected honeybee colonies affected positively the development and productivity of such colonies. For instance, Pohl (1993), applying fumidil B and Nosemack, Webster (1994), using fumagillin and fumidil B; Gregroc and Sulimanovic (1996) using fumagillin in honey-sugar patties; Rahman and Rahman (1996), applying Entakon-M, and Kochansky and Nasr (2004), using fumidil B. They all recorded significant reduction in the percentage of *Nosema* infection after treating the diseased colonies.

In addition, significant increases were recoded in the productivity of the treated colonies from brood, and honey by some authors such as; Manning (1993) and Wilde (1996) by fumagillin; Abou-Lila *et al.* (1999) using three formulations of metronidazole, bee honey, citric, malic, and ascorbic acids; El-Shemy *et al.* (1990) using wormwood extract, and liu. (1995) who recorded considerable increase in pollen and honey yields by treating *Nosema* infected colonies with neem extract.

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فاعلية بعض مواد المكافحة ضد مرض النوزيما الذي يصيب طوائف نحل العسل

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تم اجراء دراسة تفصيلية لتقييم فاعلية عقار مترونيدازول (اليزول) ومستخلص نبات الشيح البلدي ومستخلص مخلوط نبات الشيح والزعتر (في المحلول السكرى) في تثبيط تطور مرض النوزيما في طوائف نحل العسل خلال شهر فبراير من عامي ٢٠٠٢، ٢٠٠٣. كما تم دراسة التأثيرات اللاحقة لهذه المعالجات علي نشاط تربية الحضنة وتطور وزن الجسم في الشغالات وإنتاج العسل للطوائف المعالجة ويمكن تلخيص النتائج المتحصل عليها كما يلي:

- أحدث مستخلص مخلوط الشيح والزعتر نقصاً ملحوظاً في معدل الإصابة بالنوزيما مسجلاً ٧٤,٩٦، ٧١,١٣% وذلك بعد ٤ أسابيع من المعالجة في عامي ٢٠٠٢، ٢٠٠٣ علي الترتيب، تلاه عقار مترونيدازول (٧١,١٣، ٦٤,٥٥%) في حين كان مستخلص الشيح الأقل فاعلية (٦٨,٧٥، ٥٨,٧٩).
- كانت الشغالات المصابة بالنوزيما هي الأثقل وزناً في كل الأعمار وعموماً سجل أعلا وزن للجسم للشغالات عمر ١٤ يوم حيث بلغ ١٠٨,٦، ١١٠,١ مليجرام/ شغاله غير مصابة، ١٣٣,٤، ١٣٥,٩ مليجرام/ شغاله مصابه في عامي ٢٠٠٢، ٢٠٠٣ علي الترتيب في حين جاءت شغالات الطوائف المعالجة في مرتبة متوسطة.
- بخصوص نشاط الطوائف في تربية الحضنة، أظهرت الطوائف المصابة نقصاً في هذا النشاط بلغ ٥٠,٩، ٥٤,٨% في عامي الدراسة علي الترتيب مقارنة بمثيله في الطوائف الغير مصابه. هذا وقد أدت معالجة الطوائف المصابة بعقار مترونيدازول ومستخلص الشيح ومستخلص مخلوط الشيح والزعتر إلي تحسن واضح في هذا النشاط حيث إنخفض معدل النقص إلي ١٧,٨، ١١,٦، ٥,٧% في عام ٢٠٠٢، ١٩,٣، ١٦,١، ١٤,٥% في عام ٢٠٠٣ علي الترتيب مقارنة بمثيله في الطوائف الغير مصابه.

- بلغ متوسط محصول العسل السنوى ٧,٧١، ٢,٢٨، ٤,٩٢، ٣,٣٨، ٤,٦ كيلوجرام عسل/ طائفه وذلك للطوائف الغير مصابه والمصابه بالنوزيما (الغير معالجه) والطوائف المصابة والمعالجة بالمترونيدازول ومستخلص الشيح ومخلوط مستخلص الشيح والزعتر علي الترتيب.
- وينصح بتجنب إصابة طوائف نحل العسل بمرض النوزيما لمنع الأضرار المتوقعة بتطبيق كافة الوسائل الوقائية. وفي حالة الطوائف المصابة ينصح بالعلاج باستخدام خليط مستخلص الشيح والزعتر مع المحلول السكرى كوسيلة آمنه لمكافحة المرض بنجاح مع تقليل الأضرار.