Journal of Plant Protection and Pathology

Journal homepage: www.jppp.mans.edu.eg
Available online at: www. jppp.journals.ekb.eg

Garlic, *Allium sativum* L. and Onion, *Allium cepa* L. as a Potent Anti-mite *Varroa destructor*, Parasited on Honey Bee, *Apis mellifera* L. in Egypt.

Mazeed, A. R.* and E. A. El-Solimany*

Plant Protection Research Institute, ARC, Dokki, Giza, Egypt.

ABSTRACT

The parasitic mite, *Varroa destructor* is one of the most important pests attacking apiaries all over the world. The aim of work is to evaluate the effects of fresh garlic, onion, mix of them, garlic oil and onion oil against *Varroa* mite in the honey bee colonies in Sohag Governorate. Data revealed that, all tested materials were effective when compared with control. The treatment with fresh garlic led to the highest percentage of fallen *Varroa* mite with 94.29% of the total Varroa presented in the bee colony, followed insignificantly by the mixture of garlic and onion (93.60%), garlic oil (91.55%) and onion oil (89.91%), however, the lowest percentage was recorded in fresh onion treatment with 85.33% of the total Varroa presented in the bee hive. Also, it is clear that the highest reduction percentage was recorded after the first application in all materials, the number of applications needed to satisfactory Varroa control differed depending on material type.

Keywords: honey bee, *Apis mellifera*, *Varroa destructor*, *Allium sativum* , *Allium cepa*

INTRODUCTION

The ectoparasitic mite, *Varroa destructor* (Anderson and Trueman) is considered one of the most destructive pests of beehives in Egypt and all over the world (Refaei, 2011 and Alattal *et al.*, 2017). Varroa mites feed on the haemolymph of brood and adult bees, causing severe physiological disorders resulting in a loss of up to 25% of adult weight, reducing longevity of workers and drone honey bees and deformation of wings (Kanga and James 2002). Also, destroys the mechanical protective barriers of the integument and also impairs the immune system of honey bees (Glinski, 1991). Finally serves as a vector of diseases, which may cause up to 100% mortality of honey bees. The unwise use of synthetic acaricides for *V. destructor* control resulted in resistance development, in addition to contamination of colony products especially in honey, wax and Propolis (Wallner, 1999; Blasco *et al.*, 2003; Eguaras *et al.*, 2003; and Pettis, 2004). Essential oils are secondary metabolic products of plant which are volatile, natural and complex compounds. The use of essential oils and plant extracts in Varroa control as safe and effective materials had attended by many authors (Hassan *et al*., 2008; Refaei, 2011 and Islam *et al.*, 2016). From this standpoint, these experiments were designed to evaluate the efficacy of fresh garlic, onions and their oils against Varroa mite in the honey bee colonies in Sohag Governorate.

MATERIALS AND METHODS

The present experiments were carried out in an apiary in Sohag Governorate during November, and December 2019. Eighteen colonies of the honeybee, *Apis mellifera* L. were identified as being infested with *V. destructor*. Each colony consisted of 10 full-depth combs of worker bees and a queen. The colonies were divided into six equal groups, at the first, second and third groups, 50 grams of fresh garlic, 50 grams of onion and a mixture of (25g of fresh onion +25g of fresh garlic) were used, respectively. While, 2 cm of garlic oil and 2 cm of onion oil were used with the fourth and fifth group respectively. The sixth group served as a control. Oils were obtained as ready-made oil from El-captain Company for Extraction of Natural oils, plants and cosmetics "CAP PHARM", Cairo, Egypt). One application of the tested materials was applied every 3 days for 24 days (treatment period), using a filter paper (carrier) placed on the top of colonies. Control colonies received the carrier only without any test material. To monitor Varroa populations a sticky board was pushed in all hive's bottom prior to each treatment. These boards were removed, replaced by new ones daily and the trapped mites were counted. The colony entrances remained open during the experiment and applications were carried out after sunset, when all honeybees had returned to the hives. The number of mites collected after each application was recorded and the efficiency percentage of each application of these compounds was determined (Refaei, 2011). Surviving mites remaining in each colony after treatment period were killed by using Apistan (Fluvalinate) strip. Apistan strip was removed from the colonies after 30 days and dropped dead mites were counted (Marcangeli and Garcia, 2004).

The efficiency of each application was determined according to the formula (Higes *et al.*, 1997):

$$E\ (\%) = V_{D\times} 100 / V_T$$

E (%):The efficiency of each application.

V_D: Number of mites collected throughout the days following each application.

V_t: total number of collected mites [mites collected through treatment evaluation period + remaining mites collected after Apistan application].

Data obtained in the Varroa control treatments were statistically analysis using one-way analysis of variance (ANOVA). The differences between treatments and materials were subjected by Duncan Multiple Range Test (Snedecor, 1956).

* **Corresponding author.**
E-mail address: ar.mazeed@gmail.com/Elsolimany2014@yahoo.com.
DOI: 10.21608/jppp.2020.82425

RESULTS AND DISCUSSIONS

1. Effectiveness of number of applications on Varroa mortality:

Data illustrate in Fig. (1), (2), (3), (4) and (5) represent the reduction percentages due to various applications of fresh garlic, fresh onion, mixture of fresh garlic and fresh onion, garlic oil and onion oil, respectively.

Data obtained in fig.(1) showed that treatment of 50g of fresh garlic/ colony recorded the highest reduction percentage after the first application followed insignificantly by the second one (6 days) with 44.92% and 21.67% respectively. After that, the numbers of fallen mites in the colony become very few, the numbers trapped were reduced gradually to record 5.45%, 8.07%, 6.29%, 3.60%, 2.72% and 1.57% after 3, 4, 5, 6, 7 and 8 applications, respectively. The usage of garlic for two applications can eliminate about 70% of the total mites.

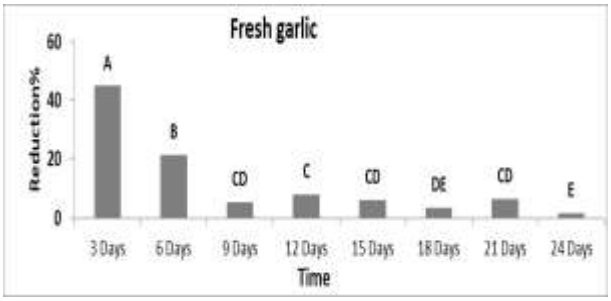

Fig. 1. Varroa reduction percentages by fresh garlic after 3, 6, 9, 12, 15, 18, 21 and 24 days of treatment. F value= 219.71. Bars marked by different letters are significantly different (Duncan's Multiple test, P ≤ 0.05)

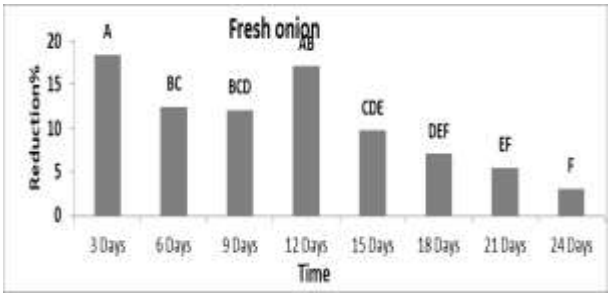

Fig. 2.Varroa reduction percentages by fresh onion after 3, 6, 9, 12, 15, 18, 21 and 24 days of treatment. F. value= 10.09. Bars marked by different letters are significantly different (Duncan's Multiple test, P ≤ 0.05).

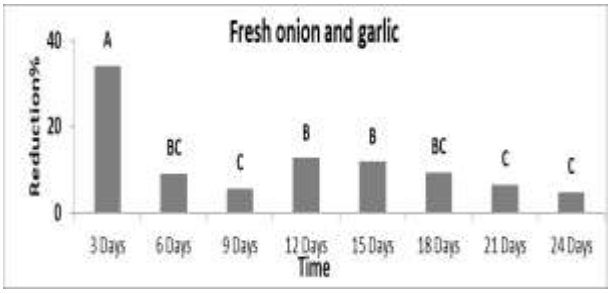

Fig. 3. Varroa reduction percentages by fresh onion and fresh garlic after 3, 6, 9, 12, 15, 18, 21 and 24 days of treatment. F value= 41.22. Bars marked by different letters are significantly different (Duncan's Multiple test, P ≤ 0.05)

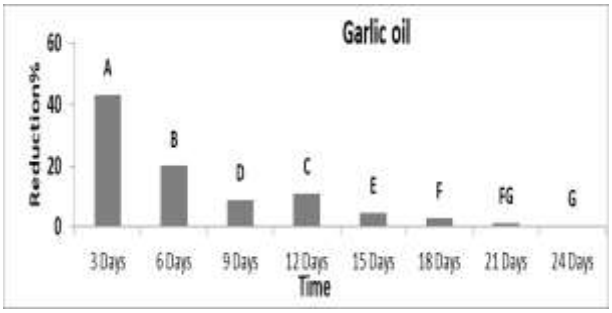

Fig. 4. Varroa reduction percentages by garlic oil after 3, 6, 9, 12, 15 18, 21 and 24 days of treatment. F value= 493.21. Bars marked by different letters are significantly different (Duncan's Multiple test, P ≤ 0.05)

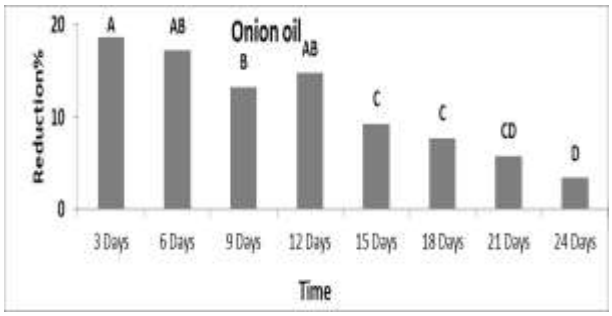

Fig. 5. Varroa reduction percentages by onion oil after 3, 6, 9, 12, 15 18, 21 and 24 days of treatment. F value= 17.26. Bars marked by different letters are significantly different (Duncan's Multiple test, P ≤ 0.05)

The results illustrated in Fig. (2), illustrated the treatment of 50g of fresh onion/ colony recorded the highest reduction percentage after the first application with 18.47%, and then the reduction percentages reached 12.46% and 12.06% after second and third applications, respectively. The fallen mites after the fourth application recorded 17.09% reduction with insignificant differences with the previous treatments. After that, the reduction percentages recorded after 5, 6, 7 and 8 applications 9.72, 7.05, 5.44 and 3.05% respectively. In order to eliminate 70% of the Varroa in the bee hive, it needs about five applications.

Data illustrated in Fig. (3) showed that the first application of mixture of 25g garlic + 25g onion/ colony recorded the highest reduction percentage, 34.13%. However, the reduction percentages after 2, 3, 4, 5, 6, 7 and 8 applications were presented by 9.11, 5.59, 12.63, 11.76, 9.23, 6.51and 4.64% respectively. It is clear that five applications of mixture of garlic and onion can eliminate about 73% of the Varroa in the bee hive.

Data arranged in Fig. (4) showed that in the colony treated with 2 ml of the garlic oil/ colony for one application recorded 43.01% reduction in Varroa numbers as the highest percentage, followed by 19.83% reduction in the second application. Also, reduction percentages of 8.78, 10.79, 4.69, 2.81, 1.27 and 0.38% were recorded after 3, 4, 5, 6, 7 and 8 applications, respectively. This means that the usage of garlic oil for three applications can eliminate 71% of the Varroa in the bee hive.

As the previous results in fresh onion, the first application of onion oil with 2 ml/ colony recorded the highest Varroa mite reduction percentage with 18.60%, followed insignificantly by the second application (17.15%) and the fourth application (14.70%), also, the reduction after the third application was 13.28% with insignificant differences with the second and the fourth applications (Figure 5). After that, the fallen mites decreased gradually with the reduction percentages by 9.29, 7.75, 5.73 and 3.41% after 5, 6, 7 and 8 applications, respectively. It concluded that to eliminate 70% of the Varroa in the bee hive, it needs about four to five applications.

In the same line, Goswami and Khan (2013) revealed that garlic oil reduced the Varroa mite population by 75.03% and 77.85% mite mortality after first and second applications, respectively, and Qayyoum *et al.* (2013) found that the highest significant mites fall was observed after 15 days in all treatments. Also, ElRoby and Darwish (2018) found that treatment with garlic gave 89.8% reduction of adult infestation. They added that the differences between the number of treatments were significant. El-Nagar *et al.* (2019) reached to the same conclusion, indicating that the food mixture composed of lemon juice + garlic extract reduced significantly the rate of Varroa infestation as compared to the control by 37.02-55.40%.

2. The total Varroa reduction by fresh onion, garlic, mixture of (onion and garlic), garlic oil and onion oil treatments:

According to the percentages of fallen Varroa from the total Varroa presented in the bee hives (Fig. 6), it is obvious that all treatments were effective compared to control. The highest percentage of fallen Varroa mite was recorded in colonies treated with fresh garlic (94.29%), followed insignificantly by the mixture of garlic and onion (93.60%), garlic oil (91.55%) and onion oil (89.91%), however, the lowest percentage was recorded in fresh onion treatment with 85.33% of the total Varroa presented in the bee hive.

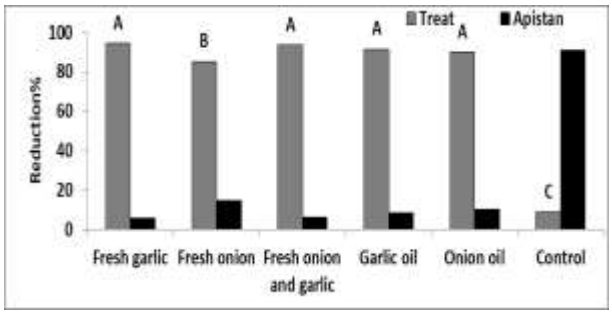

Fig. 6. The total Varroa reduction by onion and garlic treatments. F value= 5653.34. Bars marked by different letters are significantly different (Duncan's Multiple test, P ≤ 0.05)

The effect of onion oil in regard to Varroa control was listed by Imdorf *et al.* (1999). For mixture of onion and garlic, Qayyoum *et al.*(2013) suggested that a mixture of various materials plays a vital role in % reduction of mites from bee broods. Fresh garlic gave the same result of the two oils of garlic and onion, it is may due to volatile compound concentration, Sabahi *et al.*(2017) concluded that the efficacy of natural miticides in hives, is highly dependent on the delivery systems used.

Perhaps the effect of onions and garlic on the Varroa parasite is due to their volatile oils containing sulfur. Onion bulbs, consist of a complex mixture mostly formed by mono-, di-, tri-, and tetra-sulfides with different alkyl groups (Hosoda et al., 2003).The Egyptian garlic essential oil extracted by hydrodistillation had diallyl disulfide (25.2%), allyl methyl trisulfide (23.8%) and diallyltrisulfide (21.1%) as the major constituents (Romeilah *et al.*, 2010). Also, the bioactive properties and characteristic flavor of onion have been attributed to its sulfur compounds, which are present in the volatile fraction in onion oil (Vazquez-Armenta *et al.*, 2016).

Finally, it can be concluded that using fresh materials like garlic in controlling Varroa mite through an Integrated Pest Management program seems to be the ideal way because of their viability, safety, easy in application and economically cheap. However, still more studies are required to be performed on a wide scale and under different ecological conditions.

REFERENCES

Alattal, Y., AlGhamdi, A., Single, A., Ansari, M. J. and Alkathiri, H. (2017). Fertility and reproductive rate of Varroa mite, *Varroa destructor*, in native and exotic honeybee, *Apis mellifera* L., colonies under Saudi Arabia conditions. Saudi J. of Biol. Sci. 24:992–995.

Blasco, C., Fernandez, M., Pena, A., Lino, C., Silveira, M. I., and Front, G. (2003). Assessment of pesticide residues in honey samples from Portugal and Spain. J Agric. Food Chem., 51:8132-8138.

Eguaras, M., Palacio, A., Faverin, C., Basualdo, M., Del Hoyo M. and Velis, G. (2003). Efficacy of formic acid in gel for Varroa control in *Apis mellifera*: importance of the dispenser position inside the hive. Vet. Parasitol, 2003; 111:241-245.

El-Nagar, A. E., Yousif-Khalil, S. I.; El-Shakaa, S. M. A. and Helaly, W. M. (2019). Efficiency of some botanicals against *Varroa destructor* infesting honeybee colonies and their impact on brood rearing activity and clover honey yield. Zagazig J. Agric. Res., Vol. 46 No. (2): 367-375.

ElRoby, A. S. M. H. and Darwish, M. G. (2018). Biological activity of certain natural products against *Varroa destructor* (Acari: Varroidae) and their selectivity against *Apis mellifera* (Hymenoptera: Apidae). J. of Phytopath. and Pest Manag. 5(3): 67-76.

Glinski, Z. (1991). The effect of *Varroa jacobsoni* Oud. on the incidence and cause of chalk brood disease in *Apis mellifera* L. colonies. Review Agric. Entomol., 79-97.

Goswami, V. and Khan, M. S. (2013). Management of varroa mite, Varroa *destructor* by essential oil and formic acid in *Apis mellifera* Linn. Colonies. J. of Natural Products. 6: 206-210.

Hassan M. F., Margaret A. Rizk, Sally F. Allam and Zaki, A. Y. (2008). Essential Oils as Potential Control Agents Against Varroa Mite *Varroa destructor* Anderson and Trueman in Comparison with Chemical Substance on Honeybee Colonies Headed by Hybrid Local Egyptian Queens . ACARINES: J. of the Egypt. Soc. of Acarology 2:9-14.

Higes, M., Suarez, M. and Liorente, J. (1997). Comparative field trials of Varroa mite control with different components of essential oils (Thymol, Menthol and Camphor). *Res. Rev. Parasit.,* 57:21-24.

Hosoda, H., Ohmi, K., Sakaue, K. and Tanaka, K. (2003). Inhibitory effect of onion oil on browning of shredded lettuce and its active components. J. Jpn. Soc. Hortic. Sci. 72, 451–456.

Imdorf, A. , Bogdanov, S. , Ochoa R.I. and Calderone, N. W. (1999). Use of essential oils for the control of *Varroa jacobsoni* Oud. in honey bee colonies. Apidologie 30: 209-228.

Islam N.; Amjad M.; Ehsan-ul-Haq E. Stephen and Naz, F. (2016). Management of *Varroa destructor* by essential oils and formic acid in *Apis mellifera* Linn. colonies. J. of Entomol. and Zool. Studies 2016; 4(6): 97-104

Kanga, L. H. and James, R. R. (2002). Varroa control with fungal pathogens may be an option soon. American Bee J. 142(7):519-520.

Marcangeli, J. and Garcia, M. D. C. (2004). Effect of *Apis mellifera* (Apidae) honeybee brood amount on Oxavar® acaricide efficacy against the mite *Varroa destructor* (Varroidae). Rev. Soc. Ent. Agr., 63:35-38.

Pettis, J. S. (2004). A scientific note on *Varroa destructor* resistance to coumaphos in the United States. Apidologie,35:91-92.

Qayyoum, M. A., Khan, B. S. and Bashir, M. H. (2013). Efficacy of plant extracts against honey bee mite, *Varroa destructor* (Acari. Varroidae). World J. of Zool. 8 (2): 212-216.

Refaei, S. (2011). Evaluation of some natural substances against *Varroa destructor* infesting honeybee, *Apis mellifera* in Egypt. Egypt. J. Agric. Res., 89 (1): 169-175.

Romeilah, R. M., Fayed, S. A. and Mahmoud, G. I. (2010). Chemical compositions, antiviral and antioxidant activities of seven essential oils. J. Appl. Sci. Res., 6, 50–62.

Sabahi, Q., Gashout, H., Kelly, P. G. and Guzman-Novoa, E. (2017). Continuous release of oregano oil effectively and safely controls Varroa destructor infestations in honey bee colonies in a northern climate. Exp. Appl. Acarol. 72: 263–275

Snedecor, G. W. (1956). Statistical methods. Lowa State Collage Press, Ames, Iowa, U.S.A.

Vazquez-Armenta F. J., Cruz-Valenzuela M. R., Ayala-Zavala,J.F.(2016).Onion(*Allium cepa*)Essential Oils . http://www.elsevier.com/locate/permissionusematerial

Wallner, K. (1999). Varroacides and their residues in bee products. Apidology. 30:235-248.

الثوم والبصل كمواد فعالة ضد الفاروا علي نحل العسل في مصر

أحمد رمضان أحمد مزيد و عصمت أحمد السليماني

معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي – الجيزة- مصر

يعتبر أكاروس الفاروا المتطفل على حشرة نحل العسل من أهم الآفات التي تهاجم المناحل في مصر و علي مستوي العالم. أجري هذا البحث لتقييم تأثير استخدام فصوص الثوم ورؤوس البصل والخلط بينهما وزيت الثوم وزيت البصل علي الفاروا في خلايا نحل العسل في محافظة سوهاج. أوضحت النتائج أن كل المواد المستخدمة كانت فعالة مقارنة بالكنترول. أدت المعاملة بفصوص الثوم إلي أعلي نسبة تساقط للفاروا, 94,29% من العدد الكلي الموجود في الخلية, يليه بشكل غير معنوي خليط فصوص الثوم ورؤوس البصل بنسبة 93,60% ثم زيت الثوم بنسبة 91,55% ثم زيت البصل بنسبة 89,91%, بينما أقل نسبة تم تسجيلها كانت في المعاملة برؤوس البصل بنسبة 85,33% من العدد الكلي الموجود في الخلية. كذلك من الواضح أن أعلي نسبة للخفض سجلت بعد المعاملة الأولي بالنسبة لكل المواد المستخدمة. اختلف عدد المعاملات المطلوبة للحصول علي مكافحة مناسبة ومرضية للفاروا علي حسب المادة المستخدمة.