



EFFICACY AND PERSISTENCE OF ESSENTIAL OILS AND FORMIC ACID AGAINST *VARROA* MITE, *VARROA DESTRUCTOR* IN *APIS MELLIFERA* LINN. COLONIES

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ABSTRACT

Varroa destructor is a dangerous pest directly for beekeeping and indirectly for crops that require insect pollination. The present investigation has been carried out to study the efficacy and persistence of some essential oils and formic acid against *Varroa* mite in colonies of *Apis mellifera* Linn. at Pantnagar, Uttarakhand. The number of dead/fallen mites on the thick white paper sheet at bottom of the hives was used to determine the mite mortality. The results revealed among seven treatments applied for *Varroa* mite control, Garlic oil (T₂) treatment gave significantly superior results in reducing the *Varroa* mite population up to three weeks with an overall mean value of 75.03 per cent followed by formic acid giving 72.94 per cent mite mortality. The overall matricidal efficacy during the three weeks observation indicated that high persistence was observed in the garlic oil treatment with 29.69 fallen mites/hive after one week of treatment, 26.23 fallen mites/hive after two weeks of treatment and 18.33 fallen mites/hive after three weeks of treatment with mite mortality ranging from 76.00 to 76.73 per cent. The hives treated with tulsi oil, turmeric oil, ajwain oil, cinnamon oil, clove oil and formic acid also showed good persistence with mite mortality ranging from 56.85 to 75.03 per cent upto 3 weeks of the treatments.

Keywords:

Apis mellifera,
Essential oils,
Formic acid,
Varroa mite.

INTRODUCTION

The mites (Acari) that parasitize honey bees have become a global problem. They are threatening the survival of managed and feral honey bees, the beekeeping industry and, due to the role of bees in pollination, the future of many agricultural crops. *Varroa destructor* (Anderson and Trueman, 2000) formerly named *Varroa jacobsoni* Oudemans is potentially the main parasite of *Apis mellifera* L. and it can cause the collapse of untreated colonies in a few years. This mite which feeds on haemolymph of brood and adult bees causes colony disorder, weakness, decrease in brood and deformation of bees. It also reduces colony ability to pollinate plants (De Jong *et al.*, 1984). The parasite destroys the mechanical protective barriers of the integument and impairs the immune system of the bees (Glinski, 1991). The *Varroa* mite has been a threat to world beekeeping industry and now a potential threat to Indian apiculture (Gatoria *et al.*, 2004).

Several The problems associated with the use of acaricides proved considerable incentive to develop new treatment strategies and screening for potential acaricides that minimize these problems. Natural products having components with various modes of action might provide effective solution to the problem of varroaosis (Imdorf *et al.*, 1999). These natural products such as essential oils and their components or organic acids, especially formic acid, oxalic acid and citric acid were used for controlling *Varroa* mites (Mutinelli *et al.*, 1997). Keeping in view of the serious threat of *Varroa* mite in the

beekeeping and several constraints for its control, the present investigation was carried out to develop the safe and effective management option for the mite population. The present investigation aimed to determine the effective control of *Varroa* mite by using some essential oils and compared with widely used acaricide, formic acid in the hive of *A. mellifera* colonies.

MATERIALS AND METHODS

The field experiment was conducted during 2012 at Apiary, Department of Entomology College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. For conducting this experiment, in total six oils (Tulsi oil, Garlic oil, Turmeric oil, Ajwain oil, Cinnamon oil and Clove oil) along with formic acid were used for testing their efficacy against *Varroa* mite. The experiment was conducted with 8 treatments (including formic acid and untreated control) replicated three times. Before treatment all the cracks and crevices in the hive were plugged with mud. A thick white paper sheet was placed on the bottom board beneath the frames. In each treatment, two strips of blotting paper (5 × 2 inches each) were soaked in equal quantity (5 ml) for 24 hours placed at bottom of hive near to brood in treatment T₂ (garlic oil) followed by treatment T₇ (formic acid) with from 28.22 dead/fallen mites giving 75.82 percent mite mortality. Each treatment was repeated after seven days of interval and observations were taken daily from one

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day after treatment to twenty one day (At weekly) by counting the fallen/dead mite on white sheet and sheet was changed daily. The number of fallen/dead mites on the white paper sheet at the bottom of the hives was used to determine mite mortality. The data collected from experiments were statistically analysed. The randomized block design was used to find out the efficacy of different essential oils against the mite, *V. destructor*. Percent mite mortality in honey bee colonies was calculated by using following formula (Pawar, 2008)

$$\text{Percent mite mortality} = \frac{\text{Mite mortality in treatment} - \text{Mite mortality in control}}{\text{Mite mortality in treatment} + \text{Mite mortality in control}} \times 100$$

RESULTS AND DISCUSSION

The efficacy and persistence of essential oils and formic acid were evaluated against *Varroa* mite and number of fallen mites/hive/week and per cent mite mortality are summarized in Table No. 1 and 2. First week observations revealed that highest no. of dead/fallen mites per colony (29.69: 76.73 %) mortality was recorded both these treatments gave significantly higher mite mortality as compared to other treatments. The number of fallen mites recorded after one week in treatments T₃ (turmeric oil), T₆ (clove oil), T₁ (tulsi oil), T₅ (cinnamon oil) and T₄ (ajwain oil) treated colonies were 24.00, 22.98, 22.21, 21.65 and 18.32 fallen mites/hive/week with 72.72, 71.85, 71.16, 70.63 and 55.51 per cent mite mortality respectively.

Table 1: Effect of different essential oils and formic acid against *V. destructor* based on mite fall in *A. mellifera* colonies during 2012

Treatment	Compounds	Dose/hive	Average number of dead/fallen mite/ hive			
			Pre treatment Count	1 st week after treatment	2 nd week after treatment	3 rd week after treatment
T ₁	Tulsi oil	5ml	17.44	22.21	18.00	12.33
T ₂	Garlic oil	5ml	15.00	29.69	26.23	18.33
T ₃	Turmeric oil	5ml	14.67	24.00	20.44	14.66
T ₄	Ajwain oil	5ml	15.62	18.32	12.90	8.00
T ₅	Cinnamon oil	5ml	15.22	21.65	17.11	9.00
T ₆	Clove oil	5ml	13.65	22.98	19.00	13.34
T ₇	Formic acid	5ml	14.44	28.22	25.21	14.24
T ₈	Control	--	15.80	9.00	8.00	7.20
CD (P=0.05)			8.07ns	5.47	4.12	1.97

ns = non significant

Table 2: Efficacy of essential oils and formic acid against *Varroa* mite, *V. destructor* based on percent mortality in *A. mellifera* colonies

Treatment	Compounds	Average number of dead/fallen mite/ hive			Mean
		1 st week after treatment	2 nd week after treatment	3 rd week after treatment	
T ₁	Tulsi oil	71.16	69.23 (27.40)	63.78	68.56
T ₂	Garlic oil	76.73	76.00	72.36	75.03
T ₃	Turmeric oil	72.72	71.87	67.06	70.55
T ₄	Ajwain oil	55.51	61.72	53.33	56.85
T ₅	Cinnamon oil	70.63	68.14	56.25	65.00
T ₆	Clove oil	71.85	70.37	65.58	69.26
T ₇	Formic acid	75.82	75.59	67.43	72.94
T ₈	Control	0.00	0.00	0.00	0.00
CD (P=0.05)		20.82	14.00	18.57	15.09

The observations after second week indicated that number of fallen mites recorded in treatment T₂ (garlic oil) and T₇ (formic acid) were 26.69 and 25.21 dead/fallen mites/hive/week with 76.00 and 75.59 percent mite mortality which were significantly higher than in T₃ (turmeric oil), T₆ (clove oil), T₁ (tulsi oil), T₅ (cinnamon oil) and T₄ (ajwain oil) treated colonies with 20.44, 19.00, 18.00, 17.11 and 12.90 fallen mites/hive/week giving 71.87, 70.37, 69.23, 68.14 and 61.72 percent mite mortality, respectively. Similar pattern was observed in third week after treatments but with decreased number of fallen mites and percent mortality. The results showed that among seven treatments applied for *Varroa* mite control, Garlic oil (T₂) and Formic acid (T₇) treatments were

significantly better. Garlic oil (T₂) treatment gave highest mite mortality (76.73%) after one week which decreased to 76.00 percent after two weeks and then to 72.36 percent after three weeks giving an overall mortality of 75.03 percent. Similarly formic acid treatment recorded 75.82 percent mortality after one week which decreased to 75.59 percent after two weeks and further to 67.43 percent after three weeks with an overall mean mortality of 72.94 percent. Formic acid when applied singly or in combination with other oils such as menthol, eucalyptus, camphor etc. was effective in controlling *Varroa* mite (Calderone and Spirak, 1995 and Calderone et al. 1997).

CONCLUSION

It is concluded that garlic oil is effective in causing *Varroa* mite mortality to a level of 76.00 upto two weeks and the application should be repeated thereafter for achieving effective control. The effectiveness of garlic oil suggests it as an alternative to formic acid, a chemical treatment widely being used in *A. mellifera* colonies against *Varroa* mite. Depending

upon the *Varroa* mite infestation level either of the essential oils may be repeated after three weeks. Further the effectiveness of these compounds seems to be greatly dependent on temperature, time of year, colony strength and brood area. However, the use of essential oil may fit well with other control measures for integrated management of *Varroa* mite and other pests in honey bee colonies.

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