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Effect of *Varroa destructor* Anderson and Trueman infestation on *Apis mellifera* L. adults

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Abstract: Maximum incidence of Varrosis on adults of *Apis mellifera* L. (8%) was recorded in second fortnight of May 2008 corresponds to the peak in *V. destructor* population. Percent deformity was calculated by observing 100 adult bees. Deformity in adult bees was low which ranged between 0.0 to 3.0 per cent with an average of 0.52 per cent. Significant positive correlation (r = 0.77) was calculated between per cent mite infestation and per cent bee deformity which revealed that with increase in mite infestation, there was a corresponding increase in deformity of bees.

Keywords: Adult bees, *Apis mellifera*, Deformity, *Varroa destructor*

INTRODUCTION

Apiculture has huge potential in Indian rural sustainable development as increases the productivity of agricultural crops along with providing various products like honey, royal jelly, pollen, wax etc. Still commercial apiculture is not yet very common in India because of various enemies of commercial honey bee, *Apis mellifera* L. The mite *Varroa destructor* Anderson & Trueman is the most important enemy, an ectoparasitic mite that feeds on the hemolymph of adult and immature honey bees (Sammataro *et al*., 2000). Since it appeared in the western world, it has caused huge damage to the beekeeping industry and has been linked to widespread losses of honeybee colonies (more than 50%) recorded in the US and Europe since 2006 (Le Conte *et al*., 2010; Martin *et al*., 2012; Nazzi *et al*., 2012). In the present scenario, 90 per cent apiaries and 50 per cent colonies of state of Haryana are affected by this mite (Gulati *et al*., 2009). *Varroa* mite plays a critical role in the collapse of honeybee colonies. Particularly, along with Deformed Wing Virus (Martin *et al*., 2012). Varroa can destabilize the within-host dynamics of DWV with dramatic consequences on honeybee mortality (Nazzi *et al*., 2012). The most apparent effect of mite infestation at the individual honey bee level appears to be weight loss (Yang and Cox-Foster, 2007), changes in the content of sugars and proteins (Bowen-Walker and Gunn, 2001) along with alterations of the cuticular hydrocarbons (Salvy *et al*., 2001). Thus, this experiment was performed to analyse the effect of varrosis on adult bees in *Apis mellifera* colonies.

MATERIALS AND METHODS

Fortnightly data was collected via. Two methods i.e. sticky paper and hive debris methods for presence of Varroa in colonies. Each sampling method was replicated thrice in statistically comparable colonies in terms of bee strength, pollen, brood and honey.

Sampling of adults: Adult infestation was estimated by collecting 100 adult bees from brood frame (Fig.1) and hive entrance from each hive. These were brought to the laboratory and kept in BOD at 25±2^{0}C with food for 2 h to subdue their activity. After that, they were examined for the presence of mites with the help of hand lens and bees were again released to their hives. Fortnightly sampling from six *A. mellifera* colonies (three each of hive debris and sticky paper method) was done throughout the study period. Data on deformed bees were also recorded from the bottom board and at the hive entrance during each sampling period.

Per cent infestation of *Varroa destructor*: Pest potential of *V. destructor* in terms of per cent infestation was calculated at each fortnight by using following formula: % infestation = No. of mites present on adult bees X 100/ No. of mites present on adult bees

RESULTS AND DISCUSSION

Table 1 shows the fortnightly data of incidence of *V. destructor* in *A. mellifera* colonies. The incidence of

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Fig,1. *Adult bees (A. mellifera) on hive frame.*

Fig.2. *Deformed bees A. mellifera*

V. destructor on adult *A. mellifera* and its effect on bee deformity (Fig. 2) is presented in Table 2. Mite infestation ranged between 0 to 8% with an average of 1.58% incidence. The data showed the presence of mites on adult bees during the months of May, August and September, 2008 in hive debris method. Maximum

Table1. *V. destructor* population in *A. mellifera* colonies

Observation period	No. of mites/ hive in different sampling methods		
	Hive debris	**Sticky paper**	**Mean (Period)**
1st to 15th, May	36.50 (6.16)	74.00(8.71)	55.25(7.44)
16th to 31st, May	40.05 (6.48)	86.50 (9.40)	63.27(7.94)
1st to 15th, June	16.00(4.23)	37.00 (6.24)	26.50(5.24)[a]
16th to 30th, June	0.50 (1.57)	24.50 (5.13)	12.50(3.35)
1st to 15th, July	22.50 (4.94)	47.00 (6.99)	34.75(5.97)[b]
16th to 31st, July	24.00(5.09)	38.00 (6.32)	31.00(5.71)[b]
1st to 15th, August	29.00 (5.56)	30.00 (5.64)	29.50(5.60)[a,b]
16th to 31st, August	25.00(5.18)	14.50 (4.05)	19.75(4.61)[c]
1st to 15th, September	33.00(5.91)	23.50 (5.14)	28.25(5.53)[a]
16th to 30th, September	17.00(4.35)	21.50 (4.74)	19.25(4.54)[c]
1st to 15th, October	9.50 (3.38)	17.00 (4.35)	13.25(3.87)
16th to 31st, October	9.50 (3.38)	2.00 (1.98)	5.75(2.68)[d]
1st to 15th, November	2.50 (2.11)	0.00 (1.41)	1.25(1.76)[f]
16th to 30th, November	0.00 (1.41)	0.00 (1.41)	0.00(1.41)[f]
1st to 15th, December	0.00 (1.41)	0.00 (1.41)	0.00(1.41)[f]
16th to 31st, December	3.50 (2.33)	2.50 (2.11)	3.75(2.22)[e]
1st to 15th, January	4.50 (2.54)	3.00 (2.22)	3.75(2.38)[d,e]
16th to 31st, January	3.00 (2.20)	2.00 (2.00)	2.50(2.10)[e]
1st to 15th, February	0.00 (1.41)	0.00 (1.41)	0.00(1.41)[f]
16th to 28th, February	0.00 (1.41)	0.00 (1.41)	0.00(1.41)[f]
1st to 15th, March	0.00 (1.41)	0.00 1.41)	0.00(1.41)[f]
16th to 31st, March	0.00 (1.41)	0.00 (1.41)	0.00(1.41)[f]
1st to 15th, April	0.00 (1.41)	0.00 (1.41)	0.00(1.41)[f]
16th to 30th, April	0.00 (1.41)	0.00 (1.41)	0.00(1.41)[f]
Mean (Sampling method)	11.41(2.21)	17.58(2.53)	14.50

Figures in parentheses are "n+1 transformed values, Figures denoted by similar letters do not differ significantly with each other, CD (p=0.05) for Period = (0.38; sampling method = 0.11, CD (p=0.05) for period × sampling method = 0.54

Table 2. Incidence of *V. destructor* on *A. mellifera* adults (May, 2008 to April, 2009).

Period of observation	Number of bees examined	Hive debris method		Sticky paper method	
		Mite infestation (%)	Bee deformity (%)	Mite infestation (%)	Bee deformity (%)
1st to 15th, May	100	7.5	2.3	7.5	3.0
16th to 31st, May	100	8.0	3.0	9.0	5.0
1st to 15th, June	100	0.0	0.0	8.0	3.0
16th to 30th, June	100	0.0	0.0	7.0	4.0
1st to 15th, July	100	0.0	0.0	5.5	2.2
16th to 31st, July	100	0.0	0.0	6.0	1.4
1st to 15th, August	100	3.5	1.0	5.5	1.3
16th to 31st, August	100	5.5	1.3	0.0	0.0
1st to 15th, September	100	5.5	1.4	5.5	1.3
16th to 30th, September	100	6.0	2.2	5.5	0.7
Mean	100	1.58	0.52	1.58	0.72
r (Per cent infestation *vs* percent deformity)			**0.97**		**0.81**

No deformed bees were found from 1st fortnight of October to 2nd fortnight of April, 2008 mention year

incidence (8%) was recorded in second fortnight of May (2008) corresponding to the peak in *V. destructor* population in hive debris (Table 1). Per cent deformity was calculated by observing 100 adult bees. During the period of study, deformity in adult bees was low which ranged between 0.0 to 3.0 % with an average of 0.52%. Significant positive correlation (r = 0.77) was calculated between % mite infestation and % bee deformity which revealed that with increase in mite infestation, deformity in bees also showed a corresponding increase.

Similarly, in sticky paper method used for *A. mellifera* colonies, a significant positive correlation (r = 0.81) was calculated between % infestation and % deformity, which suggested an increase in mite incidence on bees led to corresponding increase in number of deformed bees (Table 2). In this method, mite infestation ranged between 0 to 9% with an average of 1.58%. Mites appeared on adult bees in first fortnight of May (7.5%) which increased to 9% in second fortnight of May, thereafter it gradually decreased to 0% in second fortnight of August but in month of September, mites were again recorded from adult bees (5%) in sticky paper method sampled colonies. Maximum % infestation was observed in second fortnight of May (9%) and least in second fortnight of August (0%).

In remaining months of study (first fortnight of October, 2008 to second fortnight of April, 2009), no mite population was detected on adult bees. Bee deformity ranged from 0 to 5% with an average of 0.72%, the highest value being in second fortnight of May (5%) and lowest in second fortnight of August (0%). No deformed bees were observed from first fortnight of October, 2008 to second fortnight of April, 2009.

It is reported that the *Varroa* stays outside the brood cells for an average of 13 days (Schulz, 1984) before entering in brood cell to reproduce. This behaviour of mite was utilized to count its number on adult bees. In the present study, sampling procedure involved the placing of collected bees in BOD for 2 h to subdue their activity, before examining them with the help of hand lens. Thereafter, the bees were released back to the hive. Although the method is comparatively laborious than dipping mites in alcohol, hot water or soaped solution (De Jong *et al.*, 1982) or ether (Burgett *et al.*, 1987; Calderone and Turcotte, 1996) but it is safer to bees than these methods in which bee mortality occurs. Other sampling method followed by some researchers is dusting of powdered sugar on collected bees (Macedo *et al.*, 2002), however, in this method some mites remain entangled on adult bee hairs. Secondly, this procedure involved vigorous shaking and in the process some bees were lost due to mortality. Additionally, it is a time consuming procedure and not practically feasible in big apiaries.

In the present investigations, the effects on adult bees were more pronounced in second fortnight of May (8-9 % bees were infested) in both sampling methods as depicted by the peak in *V. destructor* population in all test colonies. Kokkinis and Liakos (2004) estimated the average number of mites per adult bee as 7.3 and 7.0 in first and second year of their study with highest value in the end November (17.8 ± 1.8) and end September (12.6 ± 2), respectively. Bowen-Walker and Gunn (2001) observed that wet weight, dry weight and water contents of emerging honeybees (*A. mellifera* L. [Hymenoptera: Apidae]) infested with the ectoparasitic mite *Varroa*

destructor (Anderson) (Acari: Varroidae) were all negatively correlated with increasing numbers of mites. It was estimated that for every female mite present during the bees' development, the host would lose 3% of its body water. Some 8.5% of the emerging bees exhibited morphological deformities and deformity was positively correlated with increasing numbers of mites in brood cells. Deformed bees were, however, found in all categories of parasitosis, suggesting that other factors such as infectious agents may be involved, which is similar to the present study.

Maximum infestation on adult bees in the present study led to increase in deformed bees during this period (May). The significant positive correlation was observed between mite infestation and bee deformity, suggesting a high pathogenicity to deformed bees during high infestation level of mite. Similar observations were reported by De Jong *et al.* (1982), De Jong (1990) and Kokkinis and Liakos (2004) that the number of adult bees with wing malformations was more in the period of increased mite incidence which decreases with decrease in mite population. A similar trend was witnessed in present study also. A possible explanation could be the inability of parasitized adult bees, with or without deformed wings, carrying *Varroa* out of the hive as suggested by Kokkinis and Liakos (2004). Earlier, Woyke (1987) reported that *V. jacobsoni* infested a higher percentage of adult workers than *T. clareae*. In his study, the per cent infestation of adult workers varied from 1 (February) to 6.7 per cent (October) in Vietnam.

Conclusion

With increase in per cent mite infestation, per cent bee deformity also increased, which clearly showed that *Varroa* mite causes deformity of bees either in their brood stage by eating on them (as *Varroa* reproduces inside capped brood) or when brood become adult, adult bees are deformed or at adult stage or at both stages which ultimately lead to less work efficiency of adult bees.

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