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Seasonal incidence of parasitic mites on *Apis mellifera* Linn. colonies under terai agro-ecological situation of West Bengal

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Abstract
Commercial beekeeping is highly threatened by a number of biotic stresses that included different mite pests. An experiment was conducted in the Apiary unit of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India during 2018-19 and 2019-20 season to assess the seasonal incidence of different parasitic mites on the European honey bee, *Apis mellifera* Linn. colonies in the terai agro-ecological region of West Bengal. Ten number of strong *A. mellifera* colonies were used for the study. Incidence of both varroa mite, *Varroa destructor* Anderson and Trueman and tracheal mite, *Acarapis woodi* (Rennie) was found maximum during summer months, whereas during the winter months incidence of *A. woodi* was significantly lower and incidence of *V. destructor* tended to zero. Incidence of *V. destructor* was recorded maximum in month of June during both 2018-19 (14.40±2.70 mites/100 bees or 6.125±1.13 mites/100 brood cells) and 2019-20 (15.05±2.69 mites/100 bees or 6.350±1.19 mites/100 brood cells) seasons. Incidence of *A. woodi* was recorded maximum in May-June month, i.e. 34.50% bees infested in June month during 2018-19 and 28.00% bees infested in May month during 2019-20.

Keywords: *Apis mellifera, Varroa destructor, Acarapis woodi,* seasonal incidence

Introduction
Beekeeping is an excellent way of creating employment opportunity for providing support to the rural people. The terai agro-climatic situation of West Bengal has a rich floral diversity that may help in flourishing commercial beekeeping. Beekeeping with *Apis mellifera* colonies is gaining much more popularity day by day in terai region due to its higher capacity of honey production, gentleness and less tendency of absconding than our native honey bee *Apis cerana*. With the development of commercial beekeeping in this region, it is also becoming necessary to take proper care of the bee colonies. Hot and humid climate prevails during summer months in the agro-climatic region under consideration results in suffering of honey bees from a number of biotic stresses that cause great loss to bee colonies and honey yield. The biotic stresses includes different insect and non-insect pests, diseases etc. Among them the parasitic mite pests are found to be a major threat to the honey bee colonies. As the environmental and topographical condition of this region forced the honey bees to face a number of biotic and abiotic stress, it ultimately leads to reduction in the colony strength.

The ectoparasitic varroa mite, *Varroa destructor* Anderson and Trueman is generally confined to the *A. cerana*, but it is also recorded as one of the most important causes of colony loss in *A. mellifera* (Sanford *et al*., 2007) [12]. This mite was reported to cause more than 50% loss of *A. mellifera* colonies worldwide (Martin *et al*., 2012) [7]. When *V. destructor* got established in a country, it plays a major role on the beekeeping industry of that country (Sanford, 1996) [13]. The world beekeeping industry has been greatly threatened by varroa mite and now it also becomes a potential threat to Indian beekeeping (Gatoria *et al*., 2005) [3]. In India, Kumar *et al*. (1988) [6] first documented the occurrence of varroa mite on *A. mellifera* colonies in Himachal Pradesh. Tracheal mite, *Acarapis woodi* (Rennie) is another important mite pest of honey bees. Infestation of *A. woodi* is neither caused any acute disease nor devastating losses, rather it feed on hemolymph and shorten the life span of infested bees by few days (Fyg, 1964) [2].

No systemic work have so far been undertaken on mite pests of honey bee in terai agro-ecological condition of West Bengal. Keeping in view, the importance of beekeeping in the socio-economic progress of terai region of West Bengal and the impacts of different parasitic mites on the strength of *A. mellifera* colonies, the present study was undertaken with a view to observe the seasonal incidence of parasitic mites to *A. mellifera* colonies under terai region of West Bengal.

Materials and Methods

Experimental site: The field experiments were conducted at the apiary unit of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India during 2018-19 and 2019-20. The laboratory investigations were carried out in the Department of Agricultural Entomology, UBKV, Pundibari, Cooch Behar during respective years of study. The Apiary Unit, located at 26˚ 19 ' N latitude and 89˚ 23 ' E longitude at an altitude of 43 meter above the MSL (Mean Sea Level). For data collection ten strong *A. mellifera* colonies have observed during the study period.

During the investigation two parasitic mite species, varroa mite, *Varroa destructor* and tracheal mite, *Acarapis woodi* were found infesting the honey bee colonies. For confirmation of specific mites, microscopic examination was conducted in the departmental laboratory.

Estimation of seasonal incidence of varroa mite: The incidence of *V. destructor* in brood and adult bees were recorded from the selected *A. mellifera* colonies by using two different mite estimation methods (visual examination and per 100 bee methods) (Asha *et al*., 2013) [1] (Poonia *et al*., 2014) [11] weekly during the study period.

Estimation of mite population in brood cells through visual examination: For determining the populations of mites in *A. mellifera* colonies under experiment, 100 brood cells were observed from selected colonies for presence of mite with the help of lens. Data was recorded as percentage of brood cells infested with mite.

Estimation of mites per 100 bees: Randomly 100 bees were collected from the brood nests of each colonies and put into open mouthed glass bottle. After that, powdered sugar @ 5g was dusted over these collected bees which will motivate the bees for grooming and slightly agitating them. Then the jar was inverted for 4-5 minutes on a white paper and dislodged mites that were falling on the paper were counted. Data was recorded as number of mites per 100 bees.

Estimation of seasonal incidence of tracheal mite: 25 bees from each hives (total of 250 bees) were examined individually for the presence of external mites using a stereo-microscope. Then the pro thoracic tracheae were examined (M.A.F.F. 1956). Data was recorded weekly based on the percentage of bees infested by the mite and number of mites collected from 25 bees per hive.

Statistical analysis: The seasonal incidence of different mite pests were correlated with the environmental parameters by following standard statistical methodologies. Correlation, regression analysis were also done so as to determine the role of environmental parameters on the seasonal incidence of mite pests.

Results

Two different types of mite were found to cause parasitism in the *A. mellifera* colonies in this region. The mite species were observed under stereo-microscope in the laboratory of Department of Agricultural Entomology and compared with taxonomic keys for their identification. The two mite species were identified as varroa mite, *Varroa destructor* Anderson and Trueman and tracheal mite, *Acarapis woodi* (Rennie).

Seasonal incidence of varroa mite: During the 2018-19 and 2019-20 study period, the incidence of *V. destructor* was recorded by using two different methods, i.e., brood cell infestation through visual examination method and per 100 bee method. The data collected from observation stabilized and analysed and have been presented in the table-1 as well as in the corresponding diagram presented in fig-1.

Table 1: Number of *V. destructor* during 2018-19 and 2019-20 through both visual examination method and per 100 bee method

Months	100 bee method					Percentage brood infestation				
	2018-19		2019-20		Pooled mean	2018-19		2019-20		Pooled mean
	Mean (no.)	Mean±SD	Mean (no.)	Mean±SD		Mean (no.)	Mean±SD	Mean (no.)	Mean±SD	
September	0.700	0.700±0.65	0.850	0.850±0.74	0.775	0.550	0.55±0.60	0.725	0.725±0.64	0.637
October	0	0	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0	0	0
January	0	0	0.100	0.100±0.30	0.050	0	0	0.220	0.220±0.51	0.110
February	1.525	1.525±0.82	1.725	1.725±0.82	1.625	1.050	1.050±0.64	1.175	1.175±0.64	1.112
March	2.775	2.775±0.73	3.075	3.075±0.62	2.925	2.075	2.075±0.66	2.200	2.200±0.69	2.137
April	4.500	4.500±0.95	4.740	4.740±0.88	4.620	2.900	2.900±0.89	3.340	3.340±0.72	3.120
May	7.400	7.400±1.50	7.800	7.800±1.88	7.600	4.175	4.175±0.78	4.300	4.300±0.76	4.237
June	14.40	14.40±2.70	15.05	15.05±2.69	14.725	6.125	6.125±1.13	6.350	6.350±1.19	6.237
July	8.400	8.400±2.25	7.760	7.760±2.58	8.080	3.880	3.880±0.87	3.540	3.540±1.01	3.710
August	2.025	2.025±1.37	1.775	1.775±1.35	1.900	1.775	1.775±0.62	1.475	1.475±0.72	1.625

It appears from table-1 that the incidence of varroa mite was found to be higher during summer months, i.e. May-July. After that their population started declining with no mite incidence during cooler months, i.e. October-January and again started increasing from February month. During both 2018-19 and 2019-20 seasons, the peak incidence of varroa mite was recorded in June month, which was 14.40±2.70 mites/100 bees or 6.125±1.13 mites/100 brood cells during 2018-19 and 15.05±2.69 mites/100 bees or 6.350±1.19 mites/100 brood cells during 2019-20. The cumulative data of two methods was 20.525 no. of mites during the season 2018-19 and 21.400 no. of mites during the season 2019-20 (sum total of both methods). The pooled mean of two season in month of June was recorded as 14.725 no. of mites in 100 bee method and 6.327 mites/100 brood cells. During 2018-19 season primary population build up initiated in February month, whereas during 2019-20 season it initiated in January month.

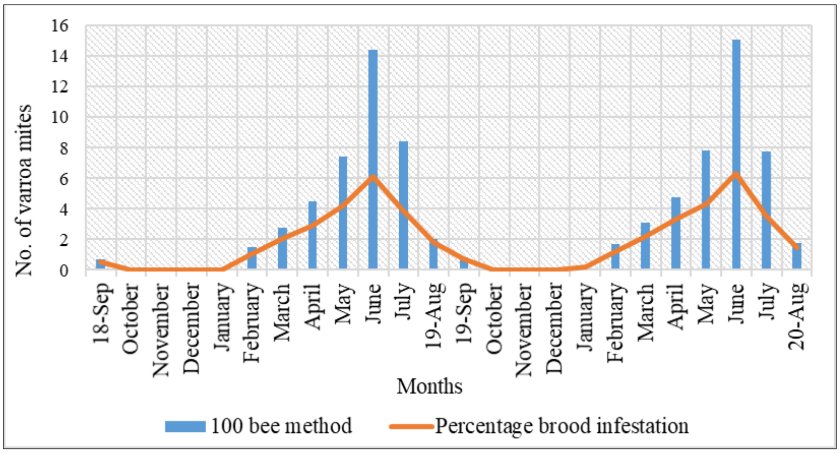

Fig 1: Seasonal incidence of varroa mite, *Varroa destructor* during 2018-19 and 2019-20

Seasonal incidence of tracheal mite: During the 2018-19 and 2019-20 study period, the incidence of *A. woodi* was recorded as no. of mites collected from 25 bees and percentage of bees infested. The data collected from observation was presented in the table-2 and the corresponding diagram was presented in fig-2 and fig-3.

Table 2: Seasonal incidence of *A. woodi* during 2018-19 and 2019-20 through both no. of tracheal mite per 25 bees and percentage bee infestation method

Months	No. of tracheal mite per 25 bees					Percentage (of 25 bees) bee infestation		
	2018-19		2019-20		Pooled mean	2018-19	2019-20	Pooled mean
	Mean (no.)	Mean±SD	Mean (no.)	Mean±SD				
September	9.925	9.925±1.95	7.325	7.325±1.56	8.625	13.60	12.10	12.85
October	8.120	8.120±1.72	6.860	6.860±1.74	7.490	13.44	14.88	14.16
November	10.750	10.750±1.61	7.750	7.750±2.08	9.250	8.70	10.30	9.50
December	1.825	1.825±1.34	1.450	1.450±1.04	1.637	6.70	8.30	7.50
January	3.060	3.060±1.48	0.860	0.860±0.83	1.960	17.28	6.88	12.08
February	3.950	3.950±1.40	2.300	2.300±1.11	3.125	20.60	18.00	19.30
March	20.150	20.150±5.62	13.425	13.425±5.58	16.787	28.20	20.80	24.50
April	22.780	22.780±3.13	18.960	18.960±2.29	20.870	29.20	27.36	28.28
May	28.275	28.275±3.50	19.150	19.150±2.55	23.712	33.10	28.00	30.55
June	27.050	27.050±2.93	23.675	23.675±3.05	25.362	34.50	24.70	29.60
July	23.660	23.660±3.00	21.580	21.580±2.04	22.620	24.64	18.96	21.80
August	20.325	20.325±2.92	12.925	12.925±3.60	16.625	18.30	11.60	14.95

Similar to varroa mite, incidence of *A. woodi* also recorded higher during hotter period of the year, i.e. March-August. But unlike varroa mite, their population didn't become extinct during the winter period. Population of tracheal mite started increasing drastically from March. During the season 2018-19 maximum no. of mites infesting 25 bees was recorded in May (28.275±3.50 mites/25 bees) whereas percentage bee infestation was maximum in June month (34.50%). During the season 2019-20 highest no. of mites (23.675±3.05 mites/25 bees) were collected in June month and percentage bee infestation was recorded maximum in May month (28%). Whereas the pooled mean of two season indicates the maximum percentage of bee infested by tracheal mite in month of May (30.55%). Infestation of *A. woodi* was recorded higher during the 2018-19 season as compared to 2019-20 season.

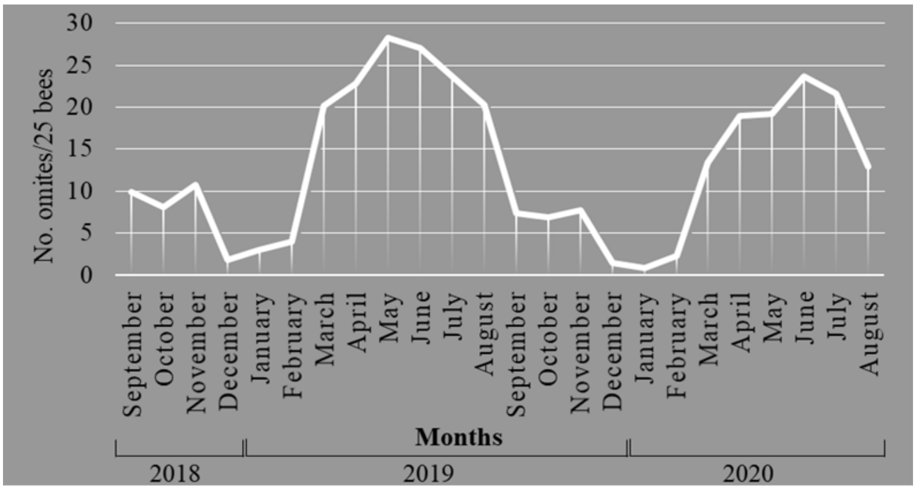

Fig 2: Number of *A. woodi* per 25 bees during 2018-19 and 2019-20

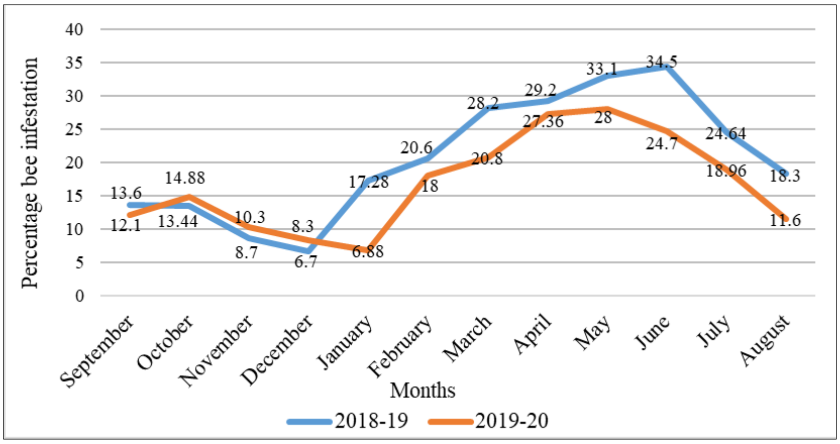

Fig 3: Percentage (of 25 bees) bee infestation by *A. woodi* during 2018-19 and 2019-20

Impact of weather parameters on mite incidence: The observations recorded during study period with regard to the incidence of different mite pests correlated statistically with various environmental parameters to find out is there any direct or indirect influence of environmental parameters on the incidence of different mite pests on *A. mellifera* colony. For that, regression equation, correlation co-efficient (r) and co-efficient of determination (R^2) haves been determined and depicted in table-3 and table-4.

Table 3: Regression equations, correlation co-efficient and co-efficient of determination of seasonal incidence of varroa mite as per 100 bee method as influenced by various environmental parameters

Environmental parameters	Regression equation	r	R^2
Temperature (max.)	y = 0.4033x - 8.4504	0.377**	0.1421
Temperature (min.)	y = 0.3429x - 2.9870	0.462**	0.2134
RH (max.)	y = 0.0692x - 2.2331	0.138^{NS}	0.0191
RH (min.)	y = 0.1235x - 4.3805	0.377**	0.1419
Rainfall per day	y = 0.0971x + 2.7961	0.287**	0.0826
Sunshine hour per day	y = -0.3451x + 5.1962	-0.155^{NS}	0.024

** Correlation is significant with 1% level of significance
^{NS} Non-significant

Table 4: Regression equations, correlation co-efficient and co-efficient of determination of seasonal incidence of tracheal mite as per 25 bee method as influenced by various environmental parameters

Environmental parameters	Regression equation	r	R^2
Temperature (max.)	y = 1.2246x - 23.055	0.563**	0.317
Temperature (min.)	y = 0.9829x - 5.3678	0.651**	0.4242
RH (max.)	y = 0.0185x + 11.647	0.018^{NS}	0.0003
RH (min.)	y = 0.2784x - 4.5543	0.418**	0.1746
Rainfall per day	y = 0.2323x + 11.537	0.338**	0.1144
Sunshine hour per day	y = -0.3138x + 14.736	-0.069^{NS}	0.0048

** Significant at 1% level of significance
^{NS} Non-significant

It has been observed that the temperature (both maximum and minimum), relative humidity (minimum) and rainfall, all these weather parameters are positively and significantly correlated with seasonal incidence of both varroa and tracheal mites. Whereas the relative humidity (maximum) have shown positive but non-significant correlation and the sunshine hour per day have shown negative and non-significant correlation with seasonal incidence of the mite pests.

Discussion

Our studies indicate that the incidence of both the mites are significantly higher during summer months. Narendra *et al.* (2016) [10] also recorded maximum mean population of varroa mite during August (29.8) and May (26.0) and minimum mean mite population during February (2.4) and January (2.3). Whereas, Kotwal *et al.* (2013) [4] found seasonal incidence of *Varroa destructor* was minimum during July (18.90 per cent) and maximum during March (40.00 per cent). Similarly, the incidence of tracheal mite was recorded maximum during late summer and autumn and minimum during spring (Muzaffar and Ahmad, 1991) [9]. However, a contrasting report was given by Kumar *et al.* (2001) [5] where the authors reported the infestation of *Acarapis woodi* in both *Apis mellifera* and *Apis cerana* colonies was significantly high during October to November months and low during March to May months in Himachal Pradesh. This may be due to location variation in conducting the experimental study.

From the study it is clear that there is a positive correlation between the incidence of mite with the environmental temperature. As the temperature started increasing from March month, incidence of both the mite species also started increasing and their population started declining from the September month with the onset of winter season. Poonia *et al.* (2014) [11] also reported the presence of maximum mite population (38 and 51 mites/per hive) in second fortnight of May which had a significant positive correlation with maximum (r = 0.659) and minimum (r = 0.648) temperature.

Conclusion

Though number of beekeepers in this region is relatively low compared to the other parts of West Bengal, but its popularity is increasing among the rural peoples of this region day by day. Beekeeping is one of the most efficient way of employment generation and has the ability to play an important role in socio-economic development of the region. But different biotic stresses constrict the growth of commercial beekeeping. Parasitic mites are one of them. From the investigation it is clear that during the summer months population of different parasitic mites become significantly higher. So, it become necessary for the beekeepers to take proper management strategies during this period. Both the mites has the potentiality to cause colony collapse and if they are not tackled properly it may cause huge loss to the beekeeper.

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