INFLUENCE OF WEATHER PARAMETERS ON BROOD REARING AND FORAGING ACTIVITIES OF INDIAN BEE, *Apis cerena*

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ABSTRACT

The studies on influence of different weather parameters on brood rearing activity including honey and pollen store as well as foraging efficiency of Indian bee, Apis cerana F were made at Navsari Agricultural University, Navsari during 2003-04 and 2004-05. For the purpose, fortnightly observations on brood rearing activity i.e. colony growth parameters, honey stores, pollen stores as well as foraging activity of pollen and non pollen foragers were recorded and correlated with prevailing weather parameters recorded at meteorological unit for the period of two years. Among different weather parameters the minimum temperature (correlation coefficient value r= -0.8770), relative humidity morning (r= -0.5180), relative humidity evening (r= -0.7632), rainfall (r=-0.5017) and number of rainy days (r=-0.6407) exhibited highly significant negative (P<0.01) correlation with area under brood (egg, grub and pupa) as indicated by coefficient of correlation r value. The sunshine hours (r= 0.5305) exhibited highly significant positive (P<0.01) influence on brood rearing activity. The weather parameters minimum temperature, morning and evening relative humidity, rain fall and number of rainy days exhibited highly significant negative (P<0.01) influences, while sun shine hours exhibited highly significant positive(P<0.01) influence on honey store, pollen store, and foraging efficiency of pollen and non pollen foragers. Maximum temperature not exhibited any influence on all the parameters under study as indicated by non significant correlation (P>0.05). The study concluded that all the weather parameters under study except maximum temperature have great influence on brood rearing activity, honey store, pollen store as well as foraging efficiency which decides success or failure of rearing A. cerana in the area.

KEY WORDS: Correlation coefficient, honey bee, weather parameters

INTRODUCTION

Indian bee, *Apiscerana* is an indigenous bee species found in nature. The various biotic and abiotic factors known to be influence the development of honeybees. Among abiotic factors the various weather parameters like temperature, relative humidity, amount of rain fall, number of rainy days; sunshine hours may have positive or negative influence on developmental parameters of honeybees. The important developmental parameters include brood rearing activity, which measured in terms of area under egg, grub and pupa as well as honey store

and pollen store. All the activities are further depending on foraging efficiency of foragers. Greater the foraging activity better the development.Brood rearing is one of the vital activities of honeybee which determine the strength of the colony. The ideal weather for good brood rearing activity in the plains type bees was a mean maximum day temperature of 34.4^0 C, long daily hours of sunshine and completely calm weather (Subbiah, 1956). Reddy (1979) reported that relative humidity and rainfall showed a positive relationship with the pollen gathering activity by the bees. Brood rearing can occur at temperature ranging from 37 to 42^0 C (Naim, 1983). Verma (1983) noticed increase in the pollen foraging activity with rise in the relative humidity, but not so affected by temperature. Mahrotra and Bisht (1984) found significant correlation of foraging activity for pollen and nectar foragers with day temperature and humidity. Abrol and Bhat (1987) reported that the foraging activity of *A. cerana* was significant and positive with temperature and non significant with relative humidity. Kaur and Sihag (1994) observed that the numbers of pollen foragers were positively and highly significantly correlated with the temperature and negatively and highly significantly with the relative humidity. Brood population of *Apisceranaindica* worker exhibited a significant, negative and linear correlation with minimum and maximum temperature, relative humidity and rainfall, however, positive correlation was observed with bright sunshine hours (Das and Rahman, 2000). To avail the information on influence of different weather factors on brood rearing activity, honey and pollen store as well as foraging efficiency of worker bees the present studies has been undertaken.

MATERIALS AND METHODS

To study the influence of various weather parameters and to record observations on brood rearing activity, honey and pollen store as well as foraging activity of pollen and non pollen forager, three colonies of *A. cerana* of uniform strength reared in standard ISI- 8 type bee hives maintained at N. M. College of Agriculture, N.A.U., Navsari for the period of March 2003 to February 2005. The colonies were examined regularly at fortnightly interval and observations on colony growth parameters like total brood area, which include area under egg, larvae and pupa of the worker bee, area under pollen store and honey stores were recorded utilizing standard technique suggested by Jeffree (1958) and Skowronck and Marcinkowski (1984). For the purpose, a wire grid was fabricated which consists of square in inches was utilized to measure area under respective colony growth parameters. The data on colony growth parameters were converted in to cm^2 by multiplying the number of square with 6.45. Both the sides of frames were measured. The observations on the number of frames covered with bees were also recorded during evening hours when all the bees returned to the hive. To study the diurnal activity of pollen and nectar foraging workers of *A. cerana*, the observations on the bees incoming with and without pollen loads were taken fortnightly at an interval of one hour starting from 05 00 h to 19 00 h. Each observation was made for five minutes. The observations were recorded throughout the study period.

The parameters like pollen store, honey store, foraging efficiency of pollen and non pollen foragers and

brood rearing activity in terms of area under eggs, larvae, pupal (sealed) brood and total brood area were correlated with the various weather parameters like maximum and minimum temperature, morning and evening relative humidity, sunshine hours, rainfall and number of rainy days. The data on the various weather parameters recorded by the Meteorological Department, College Farm, Navsari Agricultural University were utilized. The extent of correlation was worked out by using Karl Pearson's co-efficient test.

RESULTS AND DISCUSSION

The results on the investigation on the influence of various weather parameters on brood rearing activity, honey and pollen store as well as foraging efficiency of Indian honey bee, *A. cerana* were made in terms of extent of correlation for the year 2003-04, 2004-05 and pooled are presented in Table 1.

The influence of weather parameters on various developmental activity of honey bee colony was worked out by calculating the extent of correlation between them. For the purpose coefficient of correlation (r) was worked out and compared with table value at 5 % and 1 % level of significance. Based on that, pooled data on correlation of coefficient revealed that the weather parameters *viz.*, minimum temperature (r=-0.8770), morning relative humidity (r=-0.5180), evening relative humidity(r=-0.7632), amount of rainfall (r=-0.5017) and number of rainy days(r=-0.6407) exhibited highly significant negative influence (P<0.01) on the brood rearing activity in terms of total brood area (area under egg, grub, pupae). However, maximum temperature (r=0.0200) has no any significant influence on total area under brood, as evidenced by non-significant correlation (P>0.05) The sunshine hours (r=0.5305) exhibited highly significant and positive (P<0.01) correlation with total brood area. Das and Rahman (2000) reported that brood population of *A. cerana* worker exhibited a significant negative and linear correlation with minimum and maximum temperature, relative humidity and rainfall and a significant positive and linear correlation with bright sunshine hours which are in close agreement with the present investigation except with the maximum temperature.

With regards to honey store, the correlation coefficient values presented in Table 2 revealed that minimum temperature (r=-0.8436), relative humidity evening (r=-0.6934) and number of rainy days (r=-0.6081) exhibited highly significant negative (P<0.01) correlation, while amount of rainfall (r=-0.4799) exhibited significant negative (P<0.05) correlation. However, maximum temperature and relative humidity morning did not exhibited any influence on honey storage by *A. cerana* as evidenced by non significant correlation (P>0.05).

The pooled data of two years on correlation of coefficient (r) revealed that minimum temperature (r=0.8660), relative humidity evening (r=-0.7535) and number of rainy days (r=-0.6453) showed highly significant negative correlation (P<0.01), while relative humidity morning (r=-0.4796) and amount of rainfall (r=-0.5094) showed significant negative correlation (P<0.05) with activity of non pollen foragers (Table 2). The sunshine hours (r=0.5364) exhibited highly significant positive (P<0.01) influence on non pollen foraging activity by worker bees. The minimum temperature has no any significant (P>0.05) influence

on non pollen foraging activity of worker bees.

The pooled data of two years on correlation coefficient between weather parameters and pollen store by honeybees revealed that minimum temperature(r=-0.8750), relative humidity morning (r=-0.5204), relative humidity evening (r=-0.8126), amount of rainfall (r=-0.5340) and number of rainy days (r=-0.6843) exhibited highly significant negative(P<0.01) influence on pollen gathering activity by *A. cerana*(Table 2).The maximum temperature (r=0.0770) has no any influence on pollen storage by honey bee *A. cerana* as evidenced by non-significant correlation (P>0.05). The sunshine hours(r=0.5846) exhibited highly significant positive (P<0.01) influence on pollen storage by *A. cerana*. Reddy (1979) reported that relative humidity and rainfall showed a positive relationship with the pollen gathering activity by the bees. Further in 1980b the author reported that higher activity of foragers to be associated with the flowering of the desired plant. Here the present findings are not in agreement with that of Reddy (1979),the reasons may be difference in availability of pollen plants in the area.

The perusal of two years pooled data on correlation coefficient (r) between weather parameter and activity of workers for pollen foraging revealed that minimum temperature (r=-0.8926), relative humidity evening (r=-0.7663) and number of rainy days (r=-0.6455) exhibited highly significant negative (P<0.01) influence on pollen foraging activity by worker bees while relative humidity morning (r=-0.4942) and amount of rainfall (r=-0.5147) had significant negative correlation (P<0.05) (Table 2). The minimum temperature had no influence on pollen foraging activity by worker bees as correlation was non-significant (P>0.05). Verma (1983) noticed increase in the pollen foraging activity with rise in the relative humidity but not so affected by temperature. Mehrotra and Bisht (1984) found significant correlation of foraging activity for pollen and nectar foragers with day temperature and humidity. Abrol and Bhat (1987) reported that the foraging activity of *A. cerana* was significant and positive with temperature and non significant with relative humidity. Kaur and Sihag (1994) observed that the numbers of pollen foragers were positively and highly significantly correlated with the temperature and negatively and highly significantly with the relative humidity. The difference in opinion by different workers and that with present findings may be the varying climatic condition of different region in the country.

CONCLUSION

.From the investigation, in nutshell, it can be evident that the weather parameters contribute major role in influencing the brood rearing activity, honey and pollen store as well as activity of pollen and non pollen foragers of *A. cerana* in south Gujarat condition.

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Table 1: Influence of weather parameters (Correlation coefficients) on brood rearing activity of *Apis cerana*

Year	Stage of Bee	Correlation Coefficient (r)						
		Maximum Temperature	Minimum Temperature	Relative Humidity Morning	Relative Humidity Evening	Sun Shine Hours	Rain Fall	Rainy Days
2003-04	Area under egg	**0.0955 ns**	**-0.9101****	**-0.5679****	**-0.8161****	**0.6123****	**-0.5281****	**-0.6981****
	Area under larvae	**0.0139 ns**	**-0.9272****	**-0.5420****	**-0.7825****	**0.5672****	**-0.5030***	**-0.6592****
	Area under pupae	**0.0566 ns**	**-0.9106****	**-0.5545****	**-0.7950****	**0.5883****	**-0.5172****	**-0.6769****
	Total brood area	**0.0515 ns**	**-0.9179****	**-0.5544**	**-0.7972****	**0.5867****	**-0.5157****	**-0.6672****
2004-05	Area under egg	**-0.0425 ns**	**-0.9204****	**-0.4604***	**-0.7559****	**0.5792****	**-0.5343****	**-0.6629****
	Area under larvae	**-0.1270 ns**	**-0.9353****	**-0.4179***	**-0.7060****	**0.5339****	**-0.4817***	**-0.6090****
	Area under pupae	**-0.0800 ns**	**-0.9207****	**-0.4447***	**-0.7398****	**0.5438****	**-0.5119***	**-0.6313****
	Total brood area	**-0.0870 ns**	**-0.9272****	**-0.4397***	**-0.7329****	**0.5496****	**-0.5075***	**-0.6321****
Pooled	Area under egg	**0.0249 ns**	**-0.8639****	**-0.5363****	**-0.7819****	**0.5550****	**-0.5190****	**-0.6648****
	Area under larvae	**-0.0578 ns**	**-0.8897****	**-0.4986****	**-0.7438****	**0.5765****	**-0.4845****	**-0.6228****
	Area under pupae	**-0.0155 ns**	**-0.8699****	**-0.5214****	**-0.7651****	**0.5254****	**-0.5037****	**-0.6388****
	Total brood area	**-0.0200 ns**	**-0.8770****	**-0.5180****	**-0.7632****	**0.5305****	**-0.5017****	**-0.6407****

NS – Non significant (P> 0.05)

** Significant at 5% level of significance (P<0.05) (r = 0.2842 for n = 24 and r = 0.372 for n=48)*

*** Significant at 1% level of significance (P<0.01) (r =0.4034 for n=24 and r =0.5150 for n= 48)*

Table 2: Influence of weather parameters (correlation coefficients) on honey and pollen store as well as foraging efficiency of *Apis cerana*

Year	Stage of Bee	Maximum Temperature	Minimum Temperature	Relative Humidity Morning	Relative Humidity Evening	Sun Shine Hours	Rain Fall	Rainy Days
2003-04	Pollen store	0.0736^{ns}	-0.9194**	-0.5505**	-0.8274*8	0.6026**	-0.5299**	-0.6882**
	Honey store	0.1154^{ns}	-0.8459**	-0.5327**	-0.7998**	0.5933**	-0.5149**	-0.6460**
	Pollen foragers	0.3121^{ns}	-0.9267**	-0.5609**	-0.8001**	0.5808*8	-0.5243**	-0.6826**
	Non pollen foragers	0.1013^{ns}	-0.8909**	-0.5538**	-0.8077**	0.5994**	-0.5241**	-0.6475**
2004-05	Pollen store	0.0829^{ns}	-0.9086**	-0.4668*	-0.8037**	0.6319**	-0.5547**	-0.7023**
	Honey store	-0.0857^{ns}	-0.8917**	-0.2572	-0.5896**	0.6196**	-0.4515*	-0.5805**
	Pollen foragers	-0.0937^{ns}	-0.9206**	-0.4281**	-0.7334**	0.4938**	-0.5117**	-0.6127**
	Non pollen foragers	-0.0436^{ns}	-0.8424**	-0.5131*	-0.7251**	0.4594*	-0.4966*	-0.6474**
Pooled	Pollen store	0.0770^{ns}	-0.8750**	-0.5204**	-0.8126**	0.5846**	-0.5340**	-0.6843**
	Honey store	0.0090^{ns}	-0.8436**	-0.3926	-0.6934**	0.5798**	-0.4799*	-0.6081**
	Pollen foragers	-0.0330^{ns}	-0.8926**	-0.4942*	-0.7663**	0.5227**	-0.5147*	-0.6455**
	Non pollen foragers	0.0471^{ns}	-0.8660**	-0.4796*	-0.7535**	0.5364**	-0.5094*	-0.6453**

NS – Non significant (P> 0.05)

*** Significant at 5% level of significance (P<0.05) (r = 0.2842 for n = 24 and r = 0.372 for n=48)***

**** Significant at 1% level of significance (P<0.01) (r =0.4034 for n=24 and r =0.5150 for n= 48)***

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