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EFFECTS OF ABIOTIC FACTORS ON THE POPULATION DYNAMICS OF COTTON MEALY BUG *PHENACOCCUS* SP.

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ABSTRACT

Dependence of abiotic factors such temperature, and % humidity to means relative population of cotton mealy bug *Phenacoccus* sp. was quantified to discern their potential relationship. The samples were taken from the local field of alternate host at Karachi university campus. The insects were sampled and sorted in three grouped i.e., 1st and 2nd instars, 3rd instars and adults. Month wise sampling of each group showed maximum population of all age classes during May to November with gradual decline but the population sharply dropped during winter i.e. December, January and February. The field data i.e. mean S.E of population of each group was correlated with the abiotic limiting factors such as means maximum temperature means minimum temperature and means % humidity, which showed that the population of *Phenacoccus* sp was weakly and non-significantly affected by these factors.

KEYWORD: Cotton mealy bug, *Phenacoccus*, Abiotic factors, Limiting factors, Population dynamics.

INTRODUCTION

Cotton mealy bug *Phenacoccus* sp. belongs to the family Pseudococcidae: Homoptera). They are polyphagous and infest wide varieties of ornaments, vegetables, fruits and fiber crops in Pakistan. Shabbir and Choudary (1959) listed it as a minor pest of cotton *Gossypium* sp. in Pakistan although it has potential to become a major pest, as proved during recent pasts including 2007. Ahmad and Ahsan (2008) have already discussed its Biology and methodology of infestation in the field. The insects suck plants' sap and spread viral diseases in the field. It infests twigs, nodes, internodes and bolls covering the whole parts with white scales. The honey dew may evoke fungal infestation and their spores leave black spots on raw cotton reducing its quality and economical value. Babasaheb *et al*. (2014) discussed temperature based population trend of *Phancoccus solenopsis* and predicted their increased geographical suitability at higher latitude which might further aggravate the crop yield losses. In addition they expected a 4.0 fold increase in abundance in tropical and subtropical cotton areas of Brazil, South Africa, Pakistan and India due to expected climatic change. The researchers are busy to investigate the comprehensive knowledge of their life cycle and the factors that direct their population dynamics. The limiting factors that accelerate mortality and reduce longevity or fecundity and reduced oviposition rate are found to be the important factors to develop an integrated pest management (IPM) program against any pest Ahmad (1988) . In view of the aforementioned importance, the present work is found to be an effort to find out comprehensive knowledge about the population dynamic, and population fluctuation with reference to temperatures and relative % humidity which may influence the mortality or stability of pests in the field.

Jarosik & Dixon (1999) described the 19 years observation for population dynamics of the Turkey-oak aphid (*Myzocallis boerneri* Stroyan) and found that the aphids exhibited a distinct seasonal pattern of spring increase, summer decrease, early autumn increase, and late autumn decline. This is in agreement with present findings, where differences in population density in the field was observed in different months and different environmental conditions i.e., increase in population from March and maximum population from May to August and a decline was observed from November to February. They also reported that the density dependent upon population development, and their strength varied little during the course of the season.

MATERIALS AND METHODS

Different stages of *Phenacoccus* sp., were collected from the local, untreated field of alternate host *Hibiscus esculentus* (okra) at Karachi University campus. The sampling was started from March in one to two weeks old seedlings. The counting of different stages of *Phenacoccus* sp. was made by cutting one to two centimeters of infested stem, sorting and counting the various stages with the help of stereomicroscope. The insects were grouped into three classes i.e., 1st and 2nd, 3rd and adults. The samples were taken from randomly selected stems of 8 to 10 plants from top to bottom. The data of various age classes were statistically interpreted with temperature and mean percent humidity by using MINITAB (Computer Package, 1996).

RESULTS AND DISCUSSION

Month wise population dynamics of all developmental stages was investigated. The insects were grouped into three classes i.e.1st and 2nd, 3rd and adults and are presented in Figure 1 and its statistical calculation in Table 1 the data is correlated with abiotic factors i.e., maximum mean temperature, minimum mean temperature and man % humidity in Table 2. The maximum population was observed during May through November which were rapidly decrease might be due to poor food supply in the field and partly due to cold climatic condition. The population rise up with the start of March might be associated with the emergence of new crop and reached to maximum during June through July and then declined sharply in August due to heavy rain. Table 2 shows that neither of these factors significantly effect the population density and in all cases coefficient of correlation i.e., R^2 remain lower and could not exceed from 28% as in case of the population of 3rd instars nymph with mean minimum temperature (Table 2) and in all cases P-value were also much higher than 0.05 i.e., ($p>0.05$). All these results showed nonsignificant effect on the population of every nymphal instars of mealy bugs' population, it may be largely due to presence of inert, waxy covering on the body. Lema and Herren (1985) reported during their studies in the effect of constant temperature on population growth rates of the cassava mealy bug, *Phenacoccus manihoti* at four different temperatures, between 20 and 30.5^{o}C. They concluded that *P. manihoti* could persist and increase in numbers between 20 and 30.5^{o}C. In the present work the population of *Phenacoccus* sp. was found to decrease under very low and very high temperatures which is in agreement with the above reported work. Ahmad *et al.* (1995) studied the biology and population dynamics of legume bug *Piezodorus hybneri* (Gmelin) and reported that the species showed high density in the field during May through August.

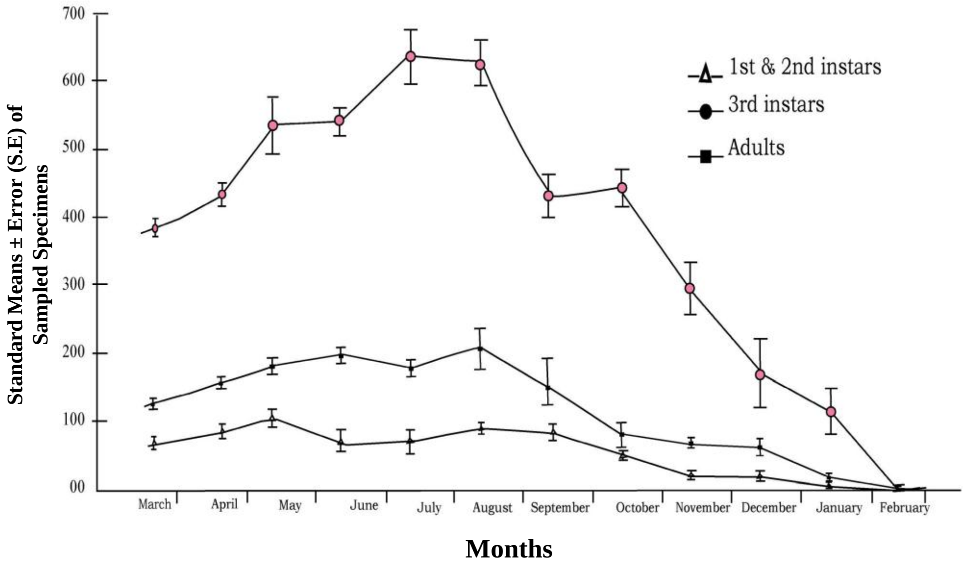

Fig. 1. Abundance of *Phenacoccus* sp. (Mean S.E) of sampled specimens.

Table 1. Standard Means ± Error (S.E) of Sampled Specimens of *Phenacoccus* sp. with reference to Physical factors at 95% C.I.

Months	% Humidity Mean ± SE	Minimum temperature Mean ± SE	Maximum temperature Mean ± SE	1^{ST} & 2^{nd} Instars Mean ± SE	3^{rd} Instars Mean ± SE	Adults Mean ± SE
March	44.17 ± 4.71	20.000 ± 0.683	32.000 ± 0.966	24.2 ± 11.3	6.17 ± 2.83	1.66 ± 0.84
April	45.83 ± 7.21	23.833 ± 0.601	34.500 ± 0.563	44.17± 4.63	17.67± 1.05	8.50 ± 0.85
May	60.00 ± 1.69	26.000 ± 0.258	34.333 ± 0.211	538.3 ± 41.9	192.5± 10.3	100.7± 8.0
June	57.00 ± 1.71	28.167 ± 0.401	36.833 ± 0.910	531.7 ± 17.2	203.3± 9.89	66.5± 6.42
July	65.33 ± 1.48	27.667 ± 0.247	33.617 ± 0.391	632.9± 25.9	181.86± 8.21	72.14 ± 5.22
August	65.00 ± 2.14	26.167 ± 0.307	32.167 ± 0.401	624.2± 31.6	203.3± 25.4	89.3 ± 7.54
September	57.83 ± 7.80	26.667 ± 0.667	34.33 ± 1.15	430.0± 30.4	147.7 ± 20.1	79.8± 13.7
October	35.33 ± 7.54	24.68 ± 1.69	35.900 ± 0.975	444.0± 23.7	87.5± 3.6	53.8± 5.53
November	27.14 ± 3.61	18.400 ± 0.792	32.367 ± 0.880	529.7± 39.1	66.67± 8.38	25.17± 2.66
December	34.33 ± 6.44	12.50 ± 1.18	28.667 ± 0.803	176.2± 52.4	57.5 ± 15.5	22.17 ± 2.65
January	24.57 ± 5.05	10.83 ± 1.74	24.50 ± 1.15	120.8 ± 31.2	15.50 ± 2.53	10.0 ± 1.57
February	42.83 ± 8.47	18.08 ± 1.47	30.417 ± 0.490	12± 1.4	22 ± 2.3	03 ± 3.1

Table 2. Comparative Analysis of Abiotic Factors on different life stages of *Phenacoccus* sp.

Age Classes	Mean Minimum temperature			Mean maximum temperature			Mean % Humidity		
	R^2	Regression equation	P	R^2	Regression equation	P	R^2	Regression equation	P
1^{st} & 2nd	27.5%	Y = - 158 + 19.6 X	0.037	20.2 %	Y= - 740 + 31.9 X	0.081^{NS}	15.3 %	Y= - 31+ 5.16 X	0.134^{NS}
3^{rd}	28.6%	Y = -72.0 + 6.89 X	0.033	21.5 %	Y = - 282 + 11.4 X	0.07^{NS}	19.7%	Y = -16.2 +2.02 X	0.231^{NS}
Adult	20.1%	Y = -24.4 + 2.65 X	0.082	20.1 %	Y = -127 + 5.05X	0.081^{NS}	9.7%	Y = -3.6 + 0.652X	0.240^{NS}

Density-independent weather variables had very little effects on the population dynamics. In the present findings Correlations with mean temperatures and mean percent humidity weakly affected the population density of *Phenacoccus* sp. Cranshaw *et al*. (2000) carried experiments to evaluate the management strategies of hawthorn mealy bug *Phenacoccus dearnessi* (King) and reported that the nymphs emerged from over wintering sites and began spring activity on 20^{th} March, 1998. First migration to twigs was noted on 14 April. The population reached at peak in early May and declined at the end of the month. Adult females first produced living young's on 27 May and continued to reproduce until 14 October. In the present investigation the *Phenacoccus* sp. started its activity from March and reached at maximum during November. Other parameters of the above mentioned work was not taken in to consideration during the present study. Horng *et al.* (2003) in their studies on effect of constant temperatures on the development, survival and reproduction of *Phenacoccus madeirensis* on *Chrysanthemum* reported that no colony was stablished at 30-40ºC, but in the present investigation the very high temperature appeared to have facilitated mortality and reduced population of *Phenacoccus* sp. Hanchinal *et al.* (2010) studied the correlation coefficients between weather parameters including maximum and minimum temperature and relative humidity on the population dynamics of mealy bug (*Phenacoccus solenopsis*) and reported a gradual increase in pest population which later declined progressively during the season that found to be in agreement of present finding. They also reported that the pest population was positively and strongly correlated with maximum temperature and negatively with other parameters. In present finding population of all life stages show negative or weak correlation between the above mentioned environmental factors the variation may be due to difference in crop types and environmental condition. Babasaheb *et al*. (2014) used minimum and maximum temperature data for analyzing within year variation of population *Phancoccus solenopsis* and reported maximum potential population increase during major cotton growing season (May-June to October-November). The present investigations revealed high population of pest during May to November and declined rapidly during winter.

It would be found useful in enhancement of Knowledge of abiotic limiting factors which drive population in the field and should be considered for the possible use in construction of IPM programs as an alternative in addition to chemical control for cotton mealy bug in Pakistan.

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