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Path analysis of abiotic factors affects the population dynamics of spider, *Oxyopes shweta* Tikader, (Aracneae-Oxyopidae-Archnida) in cotton

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Abstract
The Path analysis of abiotic factors affects the population dynamics of Spider, *Oxyopes shweta* Tikader, (Aracneae-Oxyopidae-Archnida) in Cotton studied at the Jawharlal Nehru Agriculture University, Cotton Research Station, Khandwa M.P. The data of field trials revealed that the test insect spider was first observed in the 27th SMW i.e. first week of July and remained active till 52nd SMW (4th week of december). The peak population was observed (9.01 spider / 5 plant) during 37th SMW i.e. 3rd week of September. The correlation studies between spider population and weather factors revealed that the spider population had a significant positive correlation with maximum temperature (0.610) & minimum temperature (0.614). The multiple regression computed with eight parameters i.e. maximum temperature (X1), minimum temperature (X2), morning relative humidity (X3), evening relative humidity (X4), sunshine hours (X5), wind velocity (X6), rainfall (X7), and rainy day (X8), as independent variables and spider population as dependent variables was as follows Y=-0.515 -0.704X1 +0.928X2 +0.187X3 +0.003X4 +0.258X5 -1.283X6+ 0.004X7- 0.472X8 (R^2=0.771). The path coefficient of various abiotic factors with spider population exhibited significant positive correlations were minimum temperature (0.4514). Overall result of the experiment it can be concluded that with mild to high temperature (26 to 34 ºC) and high humidity (>60%) were congenial for the development of the pest.

Keywords: Abiotic factors, cotton, *Oxyopes shweta*, population dynamics

Introduction
Cotton "White Gold" is one of the most important cash crops in India and plays a dominant role in industrial and agricultural economy of the country. Presently an estimated 60 million people depend on its cultivation, marketing, processing and exports [1]. India ranks first in the world in area and third in production. The area under cotton was 76.14 lakh hectares with a total production 167.50 lakh bales (of 170 kg each) and an average productivity (yield) of 374 kg lint/ha against the world productivity of cotton of around 620 Kg lint /ha [2]. Among various key factors responsible for poor yield of cotton in India, the damage caused by large number of insect pests during different stages of crop growth are of prime importance. A estimate, that about 20 to 25 percent yield losses were encountered due to the damage caused by insect pest [3]. Dhawan [4], recorded 162 insect species on cotton crop in India [4]. The current management practices like, the use of synthetic pesticides has caused various hazards such as pest resurgence, pesticide-resistance and invasion of various other species. It has led to increased interest in utilizing biological control agents for eco-friendly IPM programs.
Spiders are the common predator of cotton pest which occur in high numbers in cotton fields. These are carnivorous arthropods, consume a large number of cotton pests and do not damage plants. They have unique habitat and they live in almost all the environments. The Species abundance of spider communities in agricultural and horticultural ecosystem can be as high as in undisturbed natural ecosystem [5]. About 19 species in rice ecosystem, 13 species in maize, 16 species in soyabean, 18 species in oilseeds, 21 species in cotton, 57 species in sugarcane, 13 species in vegetables, 11 species in fruit crops and 26 species in coconut were recorded. In which Spider *Oxyopes shweta* Tikader, *(*Aracneae-Oxyopidae-Archnida) is one of the potential predator of cotton pest such as aphids, leafhoppers, plant hoppers, lepidopterous larvae etc. [6]. Understanding the factors influencing the occurrence and diversification of spiders are required for exploiting them to the full extent.

The potential of spiders as biological control agents of insect pests in different agro ecosystems has been studied by a number of workers [7, 8]. But, Literature perusal has shown that there are no much studies on the spiders in cotton. Keeping in view, a field trial was conducted for study the abiotic factors on the population dynamics of Spider *Oxyopes shweta* Tikader, *(*Aracneae- Oxyopidae-Archnida).

Materials and Methods

The population dynamics of Spider *Oxyopes shweta* Tikader, (Aracneae-Oxyopidae-Archnida), in relation to Abiotic factors was assessed at the Cotton Research Station, Khandwa M.P.. The Cotton, *Hirsutum* variety JK-4 was sown in observation plot of 4000 sq. m under rain fed condition in black cotton soil during the last week of June in both the year of studied. All the normal agronomical practices recommended for the region were followed for raising the crop. No plant protection measure was taken throughout the crop season. The regular observations on the population dynamics of Spider was made at weekly interval by randomly selected 25 plants from first appearance until its termination.

At the same time, observations on meteorological parameters *viz.* minimum and maximum temperature, morning and evening percent relative humidity, total rainfall per week, total rainy days per week, wind velocity (kmph) and sunshine hours per days were recorded daily. Standard meteorological Week (SMW) average of all the data collected for the pest, meteorological parameters were calculated before statistical analysis. The data thus, collected were computed and subjected to statistical analysis [9]. All the possible correlations, multiple regression and path analysis among the meteorological parameters were worked out as suggested by Gomez and Gomez [10].

Results and Discussion

Population Dynamics of Spider *Oxyopes shweta*

The data presented in Fig 1: revealed that the spider was first observed in the 27th SMW i.e. first week of July and remained active till 52nd SMW (4th week of december). The peak population was observed (9.01 spider / 5 plant) during 37th SMW i.e. 3rd week of September. The weather condition prevailed during peak population *viz.* maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine hours, wind velocity, rainfall and rainy day were 34.07°C, 26.31°C, 83.54%, 60.56%, 6.39 hours per day, 6.00kmph, 53.50 mm and 3 days respectively.

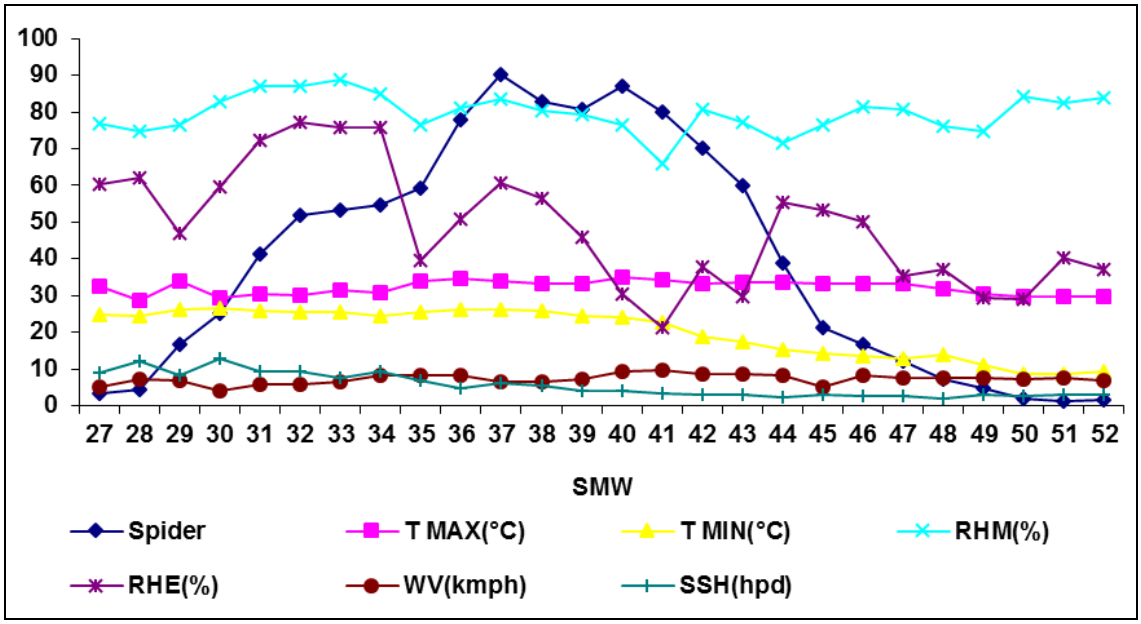

Fig 1: Influence of different weather factors on the population of spider

Simple Correlation and Regression

The data presented in Table: 2 on simple correlation studies between spider population and meteorological parameters revealed that the spider population had a significant positive correlation with max. tem. (0.610) & min. tem (0.614). After 37th SMW there was a decrease in spider population. It was estimated that every unit increase of max tem & min tem. There is increase in population of spider population is 1.023 & 0.299.

Table 2: Correlation (r) and simple regression (Y) of Spider, *Oxyopes Shweta* Tikader population with abiotic factors

S. No	Character	First Year	Second Year	Pooled of two Year
1	T MX (°C)	r= 0.477	r= 0.420	r= 0.610* Y=-28.974+1.023X
2	T MN (°C)	r= 0.534* Y=-1.332+0.273X	r= 0.608* Y=-2.092+0.309X	r= 0.614* Y=-1.99+0.299X
3	RHM (%)	r= -0.102	r= 0.129	r= -0.020
4	RHE (%)	r= 0.039	r= -0.016	r= 0.076
5	SSH (hpd)	r= 0.467	r= -0.062	r= 0.330
6	WV (kmph)	r= 0.001	r= -0.120	r= -0.003
7	RF (mm)	r= 0.055	r= 0.039	r= -0.355
8	RD (dpw)	r= 0.033	r= 0.213	r= -0.354

*& ** Showed significant at 5% & 1% level of significance respectively

Multiple Regression Analysis

The multiple regression computed with eight parameters i.e. maximum temperature (X1), minimum temperature (X2), morning relative humidity (X3), evening relative humidity (X4), sunshine hours (X5), wind velocity (X6), rainfall (X7), and rainy day (X8), as independent variables and spider population as dependent variables was as follows(figure 2).

Y=-0.515 -0.704X1 +0.928X2 +0.187X3 +0.003X4 +0.258X5 -1.283X6+ 0.004X7- 0.472X8 (R^2=0.771)

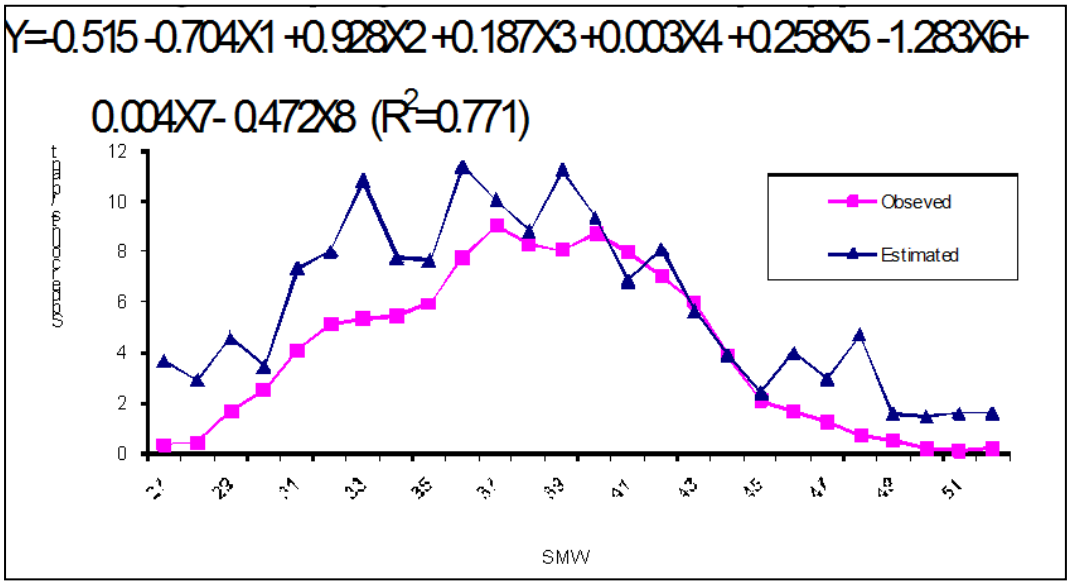

Fig 2: Multiple regression factors on spider population

Path analysis of different abiotic factors

The path coefficient of various abiotic factors with spider population has been presented in Table:2 and Figure:3. The abiotic factor exhibited significant positive correlations with spider population were minimum temperature (0.4514). The observations revealed that minimum temperature had positive and high direct effect (1.6680) followed by sunshine hours (0.1746), morning relative humidity (0.1685), rainfall (0.1359) and evening relative humidity (0.0359) respectively. The data of path coefficient effect revealed that the positive indirect effect of high magnitude of minimum temperature was obtained via rainfall (0.0756), sunshine hours (0.0591) and evening relative humidity (0.0129) respectively. The positive indirect effect of sunshine hours was observed via minimum temperature (0.5642), rainy days (0.0661) and morning relative humidity (0.0196). Positive indirect effect of morning relative humidity was obtained via wind velocity (0.1338), rainfall (0.0367), sunshine hours (0.0203), evening relative humidity (0.0170) and maximum temperature (0.0007). The positive indirect effect of rainfall was receded via minimum temperature (0.9267), morning relative humidity (0.0455), maximum temperature (0.0198) and evening relative humidity (0.0165).Positive indirect effect of evening relative humidity was obtained via minimum temperature (0.6004), morning relative humidity (0.0796) and rainfall (0.0624).

Table 2: Path coefficient of abiotic factor on spider, *Oxyopes shweta* population on cotton

	T MX (°C)	T MN (°C	RHM (%)	RHE (%)	SSH (hpd)	WV (kmph)	RF (mm)	RD (dpw)	Correlation Coefficient
T MX	-0.4252	1.0484	-0.0003	0.0015	0.1369	-0.5438	-0.0063	-0.0054	0.2058
T MN	-0.2676	1.6660	-0.0021	0.0129	0.0591	-0.9271	0.0756	0.1655	0.4515**
RHM	0.0007	-0.0209	0.1685	0.0170	0.0203	0.1338	0.0367	-0.0712	0.2848
RHE	-0.0175	0.6004	0.0796	0.0359	-0.0217	-0.5853	0.0624	-0.1436	0.0102
SSH	-0.3335	0.5642	0.0196	-0.0045	0.1746	-0.2330	-0.0473	0.0661	0.2062
WV	-0.1947	1.3004	-0.0190	0.0177	0.0342	-1.1877	0.0686	-0.1407	-0.1211
RF	0.0198	0.9267	0.0455	0.0165	-0.0608	-0.5998	0.1359	-0.2252	0.2585
RD	-0.0087	1.0475	0.0456	0.0196	-0.0438	-0.6351	0.1163	-0.2632	0.2782

Residual=0.3813, *& ** Showed significant at 5% & 1% level of significance respectively, The bold figures denote the direct effect of different factors on population of spider

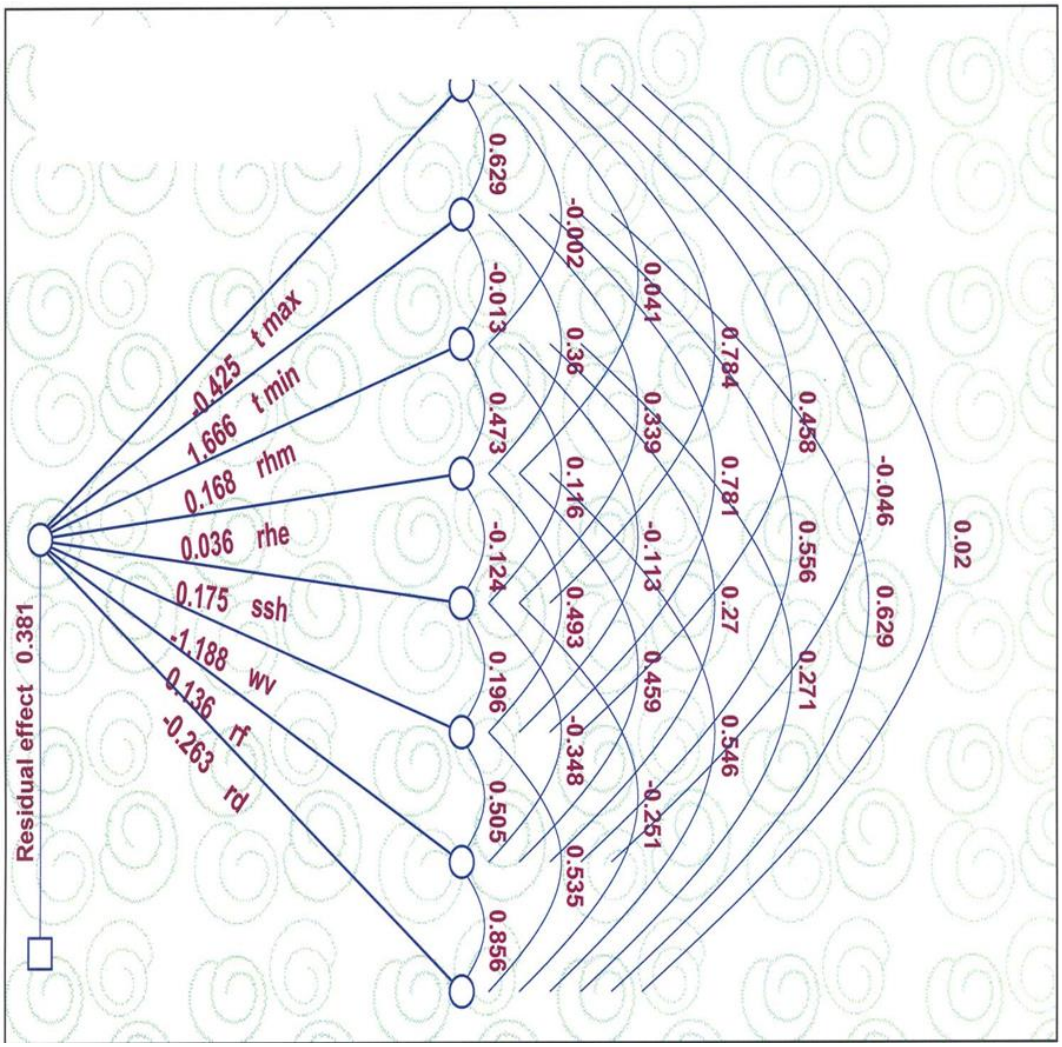

Fig 3: Phenotypical path diagram showing influence of various factors on the population of spider

The use of bio-controls agent like spiders can be an integral part of IPM. Spiders being one of the important bio-control agents play a vital role in management of insect pests in an agricultural ecosystem [11]. In the present study the peak population of spider was found during 37th SMW i.e. 3rd week of September this is probably due to the peak population of prey. The correlation analysis of spider population and weather factors suggested that the spider population had a significant positive correlation with maximum and minimum temperature.

This is in accordance with Patel *et al.* [12], who reported that there was a significant positive correlation with maximum temperature with spiders in rice and Dhaka [13] reported that maximum and minimum temperature had a significant positive correlation with spiders. Since maximum and minimum temperature was found consistent in influencing the population of spider only these two variables were regressed to know the extent of variability influencing the population of spiders.

The pooled analysis maximum and minimum temperature alone influenced the occurrence of spiders to an extent of 61.10 & 61.14% respectively. This is due to the other biotic and abiotic factors such as prey densities, crop stage, microhabitat etc., Both light and temperature levels may also affect population density indirectly by causing changes in the behavior and abundance of the prey and the predator species [14]. The role of temperature on its survival, reproduction and rate of development is studied by Li *et al.* [15] and Jackson and Pollard [16] have reviewed that the life history of spider species and they have reported that the thermal adaptations play an important role in adaptation to the surrounding environmental habitat.

They also reported that the spiders living in warmer climates can withstand higher temperature and spiders living in colder climates can adapt to cooler climate. These features are an index of their adaptation to climate change. In the present study the spider population has been found stabilized during the occurrence of pests such as leafhopper, aphids and other sucking pests which are in conformity with the published literature. Several other studies have also suggested that spiders can reduce pest infestation by virtue of their top down effects that is microhabitat use, prey selection, polyphagy nature, functional responses and numerical responses and obligate predatory behavior [17, 18].

Conclusion

Spiders are important predator of cotton pest. It serves as effective bio-control agents to reduce the pest population such as aphid, leafhopper. Among abiotic factors, maximum and minimum temperature influences the spider population significantly. The highest spider density was found in the optimum temperature range between 26.31- 34.07 ºC. There is a need for further research to determine the extent of spider predation in the multitude of crops and climate under a variety of management practices.

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