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Impact of abiotic weather parameters on seasonal incidence of two spotted spider mite (*Tetranychus urticae* Koch) and predatory mite (*Phytoseiulus persimilis*) studied on different French bean varieties at Varanasi

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Abstract

The current aimed towards screening of six popular french bean varieties against incidence of *T. urticae* and its predator *P. persimilis* across the crop season. The meteorological data like temperature, relative humidity and rainfall were collected to identify the degree of correlation of mite population over different bean varieties with various abiotic parameters. The highest no. of *T. urticae* / plant was observed on variety Arka Komal (25.65±5.10) followed by Arka Suvidha (23±3.64) and HUR-137 (21.4±4.32). The maximum no. of *P. persimilis*/ plant found on variety Arka Komal (2.25±0.25) followed by Arka Suvidha (2.25±0.18). The coefficient of correlation (r) value showed significant strong positive correlation of *T. urticae* and *P. persimilis* to Min, Max and Avg. temperature at p=0.05, whereas both species of mites showed negative correlation with relative humidity, which varied from of 63.0 to 85.5% during the crop period. No rainfall received during the crop period so, the relation couldn't be studied.

Keywords: *T. urticae*, seasonal incidence, abiotic factor, *P. persimilis*, French bean, varietal screening

Introduction

French bean is an herbaceous annual pulse with taxonomic hierarchy of order: fabales, family: fabaceae (leguminosae), genus: *Phaseolus* and species: *vulgaris*. French bean (*Phaseolus vulgaris* L.) is originated from Central America and South Mexico. The crop is widely cultivated in countries like India, Iraq, Iran, Pakistan, Bangladesh, Argentina, China, Egypt, Tanzania, USA, Netherland, Indonesia and Spain etc. The crop is known differently in different areas such as bush bean, common bean, navy bean, field bean, green bean, haricot bean, kidney bean, pop bean, flageolet bean, string bean and snap bean (Anonymous, 2013). French bean is mostly cultivated during *khariif* season on hills. However, with the development of new genotypes, the crop has been introduced in northern plains during *rabi* season with higher yield and adaptability.

Depending on the geographic location, the crop is attacked by multiple sucking pests throughout its crop duration out of which the major insects are aphids, beetles, caterpillars, pod borers, leafhoppers, whiteflies, mites, and thrips (Karel and Autrique, 1989; Quintela, 2009)^[6, 7]. Among these, the two spotted spider mite (*Tetranychus urticae* Koch) is one of the major pests for beans grown in tropics and sub-tropics and a cosmopolitan pest of many other similar pulse crops, vegetables and greenhouse crops (Hoy 2011; Jeppson *et al.* 1975)^[4, 5]. Because of smaller size, short lifecycle and nesting inside thick webbed silk, they are very difficult to be controlled by the various pesticide applications and failure of efficacy helps them to develop resistance to insecticides treated frequently.

Our present study is dedicated to investigate the seasonal incidence of two spotted spider mite (TSSM), *Tetranychus urticae* and predatory mite, *Phytoseiulus persimilis* on six different popular variety of French bean crops and to understand effect of various abiotic factors impacting mite population dynamics over the crop season.

Materials and Methods

The study on evaluation of seasonal activity of *T. urticae* on French beans were carried out in open field condition at Agricultural farm or Institute of Agricultural sciences, Banaras Hindu University, Varanasi.

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The seeds of six popular genotypes namely Swarna Priya (SP), Arka Suvidha (AS), Arka Komal (AK), Kentucky Wonder (KW), PDR-14 (PR) and HUR-137 (HR) were collected from IIVR, Varanasi. The beans were sown in a well-prepared soil bed with a planting geometry of 40cm x 25 cm spacing (Row-Row x Plant-Plant). The sampling of leaves was started from 30 days after sowing (DAS), and mite population count was recorded at each overnight interval till end of crop period.

For sampling of mites, five random plants were selected out of which 3 leaves representing top, bottom and lower canopy was plucked and kept inside zip-lock polybag with appropriate labels. The samples were brought to the instate Acarology laboratory for counting under microscope. The mite(s) count was taken from 2 cm² leaf bits under stereoscopic microscope. The data from all five plants from replications were summed-up and then divided by 5, to

generate the per plant mite availablely.

The meteorological data for specific season/ standard week were received from Agronomy department. The impact of critical abiotic parameters viz. maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall were correlated with the seasonal incidence of *T. urticae* and its predator mite (*P. persimilis*) population on the crop. The correlation coefficient (r) was statistically derived and analyzed.

Result and Discussion

The seasonal population dynamics of *T. urticae* and *P. persimilis* was studied for the rabi crop of the French bean from December- March of 2017 and 2018. The metrological data of different weather parameters were taken from Agronomy department and presented in Table 1.

Table 1: Field weather parameter data of 2017-2018 during the crop season

Standard Week No.	Month & Date	Temperature (°C)			Relative Humidity (%)			Rainfall (mm)
		Max	Min	Avg	Morn.	Even.	Avg.	
1	Jan 1- Jan 7	20.1	11.6	15.85	95	76	85.5	0
3	Jan 15- Jan 21	23	8.8	15.9	90	49	69.5	0
5	Jan 29- 04 Feb	23.8	14.1	18.95	94	57	75.5	0
7	Feb 12- Feb 18	26	12.3	19.15	87	53	70	0
9	Feb 26- 04 Mar	27.85	13.1	20.475	83	43	63	0
Mean		24.15	11.98	18.06	89.8	55.6	72.7	0
SD(±)		2.96	2.01	2.08	4.97	12.52	8.42	0

Population dynamics of mite *T. urticae* on field grown French beans

From the field screening of bean varieties in year 2017-2018, it was observed that the TSSM population was active throughout the crop season in all six varieties of the French bean. In the variety Swarna Priya, the incidence varied from lowest of 11.25 mites/ plant to 22.5 mites/ plant with mean population of 19.1±0.14. The mean no. of mite population recorded in Arka Suvidha is 23±3.64. Arka Komal variety recorded highest mean *T. urticae* population i.e. 25.65±5.10 with across the crop season as reported by Rinkikumari and Shukla (2017). The variety, Kentucky wonder recorded comparatively less mite incidence over the season than all others. The population ranged at 9.5 mites/ plant during early January and 17.25 mites/ plant 3rd standard week (SW). The mite population observed on PDR-14 varied from 13.25 to 18.75 mites/ plant with mean count of 16.95±2.23. The mite population on HUR-137 showed 2nd highest count during the

season, with mean of 21.4 mites per plant. Thus, all the bean varieties were moderately infested by the mite and remained active throughout the crop season. The mite population across the season has been presented under Table 2, Figure 1.

Population dynamics of predatory mites on field grown French beans

The *P. persimilis* mite is a great predator of *T. urticae* that feed upon all life stages (eggs, larvae, nymphs, and adults) of the mite. The highest mean mite count remained at par for variety Arka Suvidha and Arka komal i.e. 2.25± 0.18 and 2.25± 0.25 mites/ plant respectively. Similarly, the predatory mites count found on second highest in number on the variety Swarna Priya 2.1±0.14, followed by Kentucky wonder (1.8±0.41) and HUR-137 (1.65±0.34), respectively. The seasonal mean incidence of *P. persimilis* was lowest (1.4±0.34) on the variety PDR-14 (Table 2).

Table 2: No. of mites per plant observed on different French bean crop varieties during the crop season

Standard Week No.	Swarna Priya		Arka Suvidha		Arka Komal		
	<i>T. urticae</i>	<i>P. persimilis</i>	<i>T. urticae</i>	<i>P. persimilis</i>	<i>T. urticae</i>	<i>P. persimilis</i>	
1	11.25	2	16.5	2.25	16.75	2.25	
3	20.5	2	24.25	2	26	2.00	
5	19.75	2.25	24.75	2.25	28.25	2.00	
7	22.5	2	24.5	2.25	29	2.50	
9	21.5	2.25	25	2.5	28.25	2.50	
Mean		19.1	2.1	23	2.25	25.65	2.25
SD(±)		4.51	0.14	3.64	0.18	5.10	0.25
Standard Week No.	Kentucky Wonder		PDR-14		HUR-137		
	<i>T. urticae</i>	<i>P. persimilis</i>	<i>T. urticae</i>	<i>P. persimilis</i>	<i>T. urticae</i>	<i>P. persimilis</i>	
1	9.5	1.25	13.25	1.25	14	1.5	
3	17.25	1.5	16.5	1.25	21.75	1.5	
5	17.25	2	18	1.25	22.5	1.25	
7	17	2	18.75	1.25	23.75	2	
9	17	2.25	18.25	2.00	25	2	
Mean		15.6	1.8	16.95	1.4	21.4	1.65
SD(±)		3.41	0.41	2.23	0.34	4.32	0.34

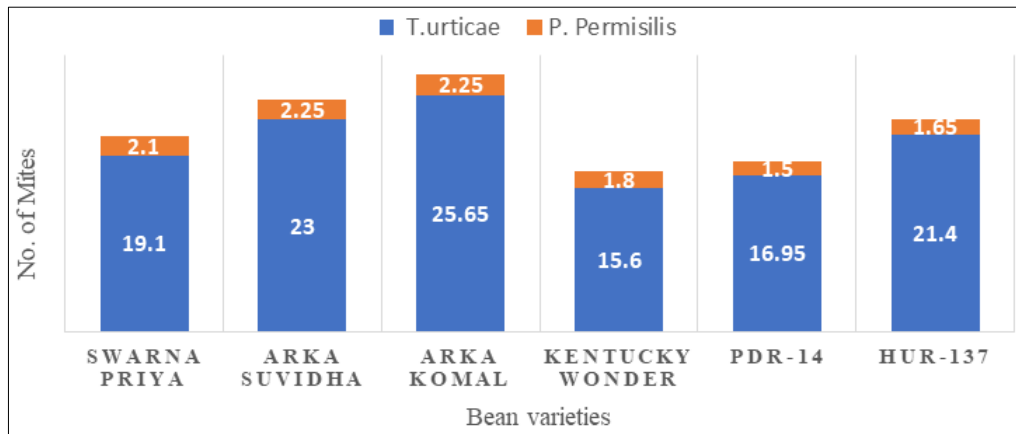


Fig 1: Mean mite population over six varieties of French beans

Abiotic parameters in correlation with *T. urticae* mite population

The mite incidences data recorded over the season from open field Bean cultivations was recorded and their interaction with weather parameters was assessed via correlation -regression analysis. As presented in Table 2, at open field conditions the mite population is varied a lot with abiotic factors and the predatory mite population is also co-related to the incidence of *T. urticae* population. The data recorded for spider mite, *T. urticae* showed positive co-relation with Max. Temperature, Min. temperature, and Avg. temperature for most of the bean varieties. For ‘r’ values was high for all the varieties when analyzed for max. temperature *i.e.* SP- 0.846, AS- 0.779, AK- 0.838, KW- 0.743, PR-0.882, HR-0.918 (Table 3). The Min. temperature is positively but poorly correlated with *T. urticae* incidence over the varieties except Kentucky wonder. The correlation coefficient values (r) for different varieties in relation to mite population are SP- 0.102, AS-0.168, AK-0.287, PR- 0.396, HR- 0.071. All varieties showed strong positive relation with Avg. temperature (r=0.846) throughout the and poorly positive towards Min. temperature (r=0.102). Five out of six varieties showed significantly strong positive relation with incidences of mite population at p=0.05 level, whereas the correlation coefficient between avg. temperature was not statistically significant for varieties except Swarna Priya (r=0.649). Chandra Sekhar *et al.* (2008) [2] reported more mites during high temperature (March/April 2005) in grape ecosystems of Andhra Pradesh, which relates to the outcome.

The Avg. relative humidity of the filed area was 85.5% at start of the crop (Dec - Jan) and reduced to 63% towards end of the crop season (Table 1). The mite population showed negative correlation with relative humidity (Morning, evening

and Avg). The study showed strong negative relationship with morning and evening RH that means the higher the RH the lower was the mite population on the crop variety. The significant negative relation against *T. urticae* is observed for Swarna Priya (r= -0.893), Arka Suvidha (r= -0.862), Arka Komal (r= -0.827), Kentucky Wonder (r= -0.837) and HUR-137 (r= -0.922). The interaction between RH and mite population was non-significant for the variety PDR-14 (r= -0.805) (Table 3).

Abiotic parameters in correlation with *P. persimilis* mite population

The field population of *P. persimilis* recorded in French bean was significantly less throughout the season across all the varieties. The mean population varied at a range of 1.5 to 2.25 mites/ plant. Like *T. urticae*, the *P.persimilis* population is greatly dependent and co-related with temperature parameter (Elham *et al.*, 2011) [3]. The mite showed strong positive correlation with the Max, Min and Avg. temperature during the crop season. The mite population of Swarna Priya, Arka Suvidha and Kentucky wonder showed significant positive correlation with Avg. temperature having ‘r’ value 0.722, 0.776 and 0.977 respectively (Table 3). Whereas the mite population in varieties named Arka Komal, PDR-14 and HUR-137 the co-relation is not significant at p=0.05 level. As like, *T. urticae* population the predatory mite also showed negative correlation with relative humidity parameter. Three varieties showed significantly negative correlation to the *P.persimilis* population in reaction to the average RH *viz.* Swarna Priya (r= -0.374), Kentucky Wonder (r= -0.754) and HUR-137 (-0.611). The mite abundance on rest other varieties were non-significant at p=0.05.

Table 3: Correlation matrix of *T. urticae* and *P. persimilis* with abiotic parameters

Bean Varieties	Mite Incidence	Temperature (°C)			Relative Humidity (%)			Rainfall (mm)	<i>T. urticae</i> vs <i>P. persimilis</i>
		Max	Min	Avg	Morning	Evening	Avg	Total	
Swarna Priya	<i>T. urticae</i>	0.846	0.102	0.649	-0.710	-0.919	-0.893*	0	0.309*
	<i>P. persimilis</i>	0.517	0.737	0.722*	0.722	-0.408	-0.374*	0	
Arka Suvidha	<i>T. urticae</i>	0.799	0.168	0.648*	-0.607	-0.918	-0.862*	0	0.073
	<i>P. persimilis</i>	0.580	0.758	0.776*	-0.498	-0.169	-0.273	0	
Arka Komal	<i>T. urticae</i>	0.838	0.287	0.733*	-0.615	-0.868	-0.827*	0	0.147*
	<i>P. persimilis</i>	0.596	0.311	0.573	-0.704	-0.200	-0.356	0	
Kentucky Wonder	<i>T. urticae</i>	0.743	0.094	0.816*	-0.559	-0.824	-0.837*	0	0.731*
	<i>P. persimilis</i>	0.934	0.654	0.977*	-0.698	-0.736	-0.754*	0	
PDR-14	<i>T. urticae</i>	0.882	0.396	0.816*	-0.649	-0.824	-0.805	0	0.326
	<i>P. persimilis</i>	0.700	0.312	0.647	-0.765	-0.563	-0.644	0	
HUR-137	<i>T. urticae</i>	0.918	0.254	0.773*	-0.756	-0.940	-0.922*	0	0.466*
	<i>P. persimilis</i>	0.722	0.071	0.546	-0.877	-0.473	-0.611*	0	

Conclusion

The study concluded with the outcome that *T. urticae* population varied significantly across different French bean varieties under trial and on the abundance in the season Dec – March is greatly dependent on the temperature prevailing during the season. The availability of predatory mite fauna *P. persimilis* on the bean crops were comparatively less and directly proportional to the no. of *T. urticae* present on the crop and average temperature of the region. Relative humidity showed reverse correlation on population of both mites. The variety Arka Komal proved to be the highly preferred host for *T. urticae* and Kentucky wonder is least preferred by the mite.

Future Scope

French bean crop is less studied on the aspect of mite incidence, so current study mite support researchers to understand the plant-mite interaction with weather parameters at this region and to prepare the plant protection measures accordingly.

Author contributions

1. 1st and communicating author- Sandeep kumar Sathua: conducted the study, designed the experiment, collected the data; performed the analysis; wrote the paper.
2. 2nd Author- Dr. R. N. Singh: Conceived and designed the analysis, contributed data analysis tools; supervised the study.

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Conflict of interest

All authors here by disclosed having No conflict of interest including any financial, personal or other relationships with other people or organizations that can influence our work.

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