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Population Dynamics and Efficacy of Newer Molecules of Insecticides Against Red Spider Mite, *Tetranychus urticae* Koch on Yard Long Bean, *Vigna unguiculata* subsp. *Sesquipedalis*

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***Abstract*:** Field experiments were conducted to study the population fluctuation of two spotted red spider mite (*Tetranychus urticae* Koch) in relation with different weather parameters and efficacy of newer insecticides against major pests of yard long bean during 2018-2019 under unprotected conditions at AHRS, Bhavikere, UAHS, Shivamogga, Karnataka. During *Kharif*, the results revealed that the mite population commenced from 37th to 48th standard week. Mite population ranged from 5.02 to 13.70 mites per 2.5 cm^2 leaf area. During *Rabi,* the mite population ranged from 1.69 to 21.50 mites per 2.5 cm^2 leaf area. The incidence of mites in both seasons showed significant and positive correlation with maximum temperature. Whereas, minimum temperatur, maximum relative humidity, minimum relative humidity and rainfall showed a significant and negative correlation with mite population. Among the insecticides tested, the highest percent reduction of mites was recorded in the treatments Spiromesifen 22.9 SC (85.60 %) followed by Fenazaquin 10 EC (82.95 %), Diafenthiuron (78.38 %) and Chlorfenapyr 10 EC (73.40 %). However, least percent reduction of mite population was observed in azadirachtin (51.79 %) treated plot when compared to untreated control.

Key words: Yard long bean, *Tetranychus urticae*, Abiotic factors, Newer insecticides.

II. INTRODUCTION

The Yard long bean (*Vigna unguiculata* subsp. *sesquipedalis*) is a legume cultivated for its edible green pods containing immature seeds, like the green bean. It is also known as aspargas bean, pea bean, long-podded cowpea, Chinese long bean, snake bean, bodi, and bora (Purseglove, 1977). The yard long bean was originated probably in the Middle West Africa or Southern China. In India, Kerala contributes a major share, accounting for nearly 90 per cent in terms of both area and production followed by Karnataka and Tamil Nadu . The area of yard long beans in India is about 18,560–20,160 ha (Saurabh *et al*., 2018). Yardlong beans are a significant source of nutrition. The U. S. Department of Agriculture (2005) reported that yardlong beans are a good source of both vitamins A and C, providing 17% and 31% of the recommended daily allowance for these vitamins, respectively.

During the cultivation, the farmer faces various problems in pest management. The important constraints for lowering yield and poor quality of yard long bean is incidence of insect pests. The major insect pests which severely damage yard long bean during all growth stages are the bean aphid, *A. craccivora*, leaf hopper, *Emposca terminalis Distanct*, thrips, *Megalurothrips usitatus* and red spider mites, *Tetranychus urticae* (Grubben, 1993).

Recently, there is a change in agricultural scenario and mites are becoming serious pest in most of the crops and yard long bean is no exception. The spider mite, *Tetranychus urticae* Koch, poses serious threat to yard long bean crop particularly during spring, summer and post rainy seasons. This crop is infested mainly by six different mite pest species, *viz*., *Tetranychus urticae*, *T. macfarlanei*, *T. ludeni*, *Brevipalpus phoenicis*, *Polyphagotarsonemus latus* and *Aceria lycopersici* (Gupta, 1985; Prasad and Singh, 2011). Out of these mite species, *T. urticae* is responsible for causing the loss of foliage of the crop plant resulting in reduction of the economic yield of fruits ranging from 15-20 % depending upon cropping season and agro-climatic conditions. *T. urticae* is well adapted to various environmental conditions, causing loss of quality and yield or death of plants by sucking out the contents of leaf cells (Mondel and Ara, 2006; Kumaran *et al*., 2007). Mite causes direct damage in terms of loss of chlorophyll, stunting of growth, stippling, webbing, leaf yellowing, leaf whitening, defoliation, leaf burning, reduction in size and quality of fruits, appearance of various types of plant deformities, followed by death etc. which severely affect the yield and in extreme outbreaks, plant death. Indirect effects of mite feeding may include decreased photosynthesis and transpiration. Due to high reproductive potential and extremely short life cycle, combined with frequent acaricide applications this mite has developed resistance to almost all conventional pesticides in vogue (Chiasson *et al*., 2004; Van Leeuwen *et al*., 2005). The mites become serious pests because they have several generations per season. Phytophagous nature, high reproductive potential and short life cycle contributed rapid resistance development to many acaricides even after few applications (Devine *et al*., 2001; Stumpf and Nauen, 2001).

Reports on incidence of insect pests and their management techniques for the yard long beans in its major growing areas of India are limited. Review of literature revealed that in our state, no work has been conducted on the insect pests of the yard long bean. The present study was, therefore, undertaken to know the level of incidence and management of mites by using different insecticides in yard long bean.

III. MATERIALS AND METHODS

3.1 Study on population dynamics of red spider mite in yard long bean during 2018-2019

Field experiments on the population dynamics was carried out by raising the crop in two seasons during 2018-2019 at AHRS, Bhavikere, UAHS, Shivamogga, Karnataka. Arka Mangala variety was sown with a spacing of 120x 30 cm in 660 m^2 area. The experimental area was kept free from insecticidal sprays, and observations made on 10 randomly selected and tagged plants at weekly interval from one week after sowing till the harvest.

3.2 Study on efficacy of selected insecticides against red spider mite in yard long bean during 2018-2019

Investigations were carried out to evaluate the efficacy of newer molecules of insecticides *viz*., acetamiprid 20 SP, imidacloprid 17.5 SL, chlorfenapyr 10 EC, diafenthiuron 50 EC, spiromesifen 22.9 SC, fenazaquin 10 EC, azadirachtin 10000 ppm and acephate75 SP against mits under natural field condition during 2018-2019 at AHRS, Bhavikere, UAHS, Shivamogga, Karnataka. Arka Mangala variety of yard long bean was sown with a spacing of 120 cm x 30 cm in a gross plot size of 745 m^2 area. The crop was raised as per package of practices except plant protection measures against mites. The field experiment was laid out in randomized block design (RCBD) with nine treatments and three replications comprising of different newer molecules of insecticides along with an untreated control (Table 1).

Sampling procedure

The nymphs and adults of mites were counted from three leaves *i.e*., one each from top, middle and bottom canopy of randomly selected plants. Total number of mites from each plant was estimated and the population was expressed in terms of mean number of mites per 2.5 cm^2 leaf area.

For recording observations, five plants were randomly selected from each plot and observations on mites were recorded at one day before spraying and 1, 3, 5 and 7 days after each spraying.

Observations on mites of yard long bean were made with standard procedures.

Per cent reduction over control was also worked out using the following formula.

$$\text{Per cent reduction over control} = \frac{\text{Pest population in control} - \text{Pest population in treatment}}{\text{Pest population in control}} \times 100$$

Statistical analysis

All the data recorded were subjected to statistical analysis as per the randomized block design procedure. The data was subjected to the ANOVA. The SPSS software and WASP softwares were used and for average data, square root transformation, for per centage data arc sine transformation were used.

Table1. Details of the insecticides tested against mites in yard long bean

Treatments	Chemicals	Dosage (ml or gm per lit)	Trade name
T1	Acetamiprid 20 SP	0.3 g/l	Pride
T2	Imidacloprid 17.8 SL	0.5 ml/l	Confider
T3	Chlorfenapyr 10 EC	1.0 ml/l	Interprid
T4	Diafenthiuron 50 WP	1.0 g/l	Peagasus
T5	Spiromesifen 22.9 SC	0.50 ml/l	Oberon
T6	Fenazaquin 10 EC	2.0 ml/l	Magister
T7	Azadirachtin 10000 ppm	2.0 ml/l	Neembicidine
T8	Acephate 75 SP	1.5 gm/l	Acetaf
T9	Untreated control	-	-

IV. RESULTS AND DISCUSSION

4.1 Study on population dynamics of red spider mite in yard long bean during 2018-2019

The study on seasonal incidence of mite population of yard long bean was carried out by raising the two crops during *Kharif* and *Rabi* 2018-19 at AHRS, Bavikere, Shivamogga. An attempt was made to establish the relationship between mites population and weather parameters *viz*., total rainfall, maximum temperature and minimum temperature by correlation and regression statistical analysis and results are presented here.

During *Kharif* season, the incidence of a two spotted red spider mites population, *Tetranychus urticae* Koch was noticed during the crop season revealed that the mites population was first observed in the 37th SMW. Initially, the population of mites was 8.36 mite per

2.5 cm^2 leaf area. The population gradually increased and reached a peak population of 13.40 mites per 2.5 cm^2 leaf during 45th SMW. A gradual decline in the mite population was observed after that. The lowest mite population recorded during the crop period was 5.02 mites per 2.5 cm^2 leaf area (Table 2) .

There was a non-significant negative correlation between red spider mite population and maximum relative humidity (r = -0.302), minimum relative humidity (r = -0.695) and minimum temperature (r = -0.258). The mite population showed a non-significant negative correlation with rainfall (r = -0.238) and it was positively correlated with maximum temperature (r = 0.696). However, these correlations were significant. The equation obtained when the data subjected to multiple linear regression analysis was $Y= -90.320-0.691X_1+3.805X_2-2.074X_3-0.039X_4-0.428X_5-12.890$. The value of the coefficient of determination R^2 revealed that the seasonal incidence of mites was influenced by weather parameters to the extent of 65.60 per cent (Table 3).

Butani (1974) recorded that September to January was the active season for mites on field bean under field condition. The present findings are supported by the reports of Norboo *et al.* (2017) a positive correlation was obtained between mite population and maximum temperature. The population of mite was negatively correlated with minimum temperature, relative humidity and rainfall.

During *rabi* season, the incidence of mites population was observed in the 3rd SMW and the first observation was recorded on 3rd weeks of January. Initially, the population of mites were low (1.69 mites per 2.5 cm^2 leaf area) and gradually increased and reached a peak in 11th SMW (21.50 mites per 2.5 cm^2 leaf). The population of mites started to decline after that. The lowest mite population recorded during the crop period was 1.69 mites per 2.5 cm^2 leaf (Table 2).

The present findings are supported by the reports of Kataria and Kumar (2016) studied the seasonal incidence of mites in beans crop. The result indicated that the maximum population of the pest was seen from January to March.

Similar trend was reported by Kumar and Sharma (1991) but the mites appeared in the 1st week of February and reached a maximum 4th week of March during summer on okra.

Meena *et al*. (2013) also reported a similar relation of abiotic factors with yellow mite in chilli crop.

Table 2: Seasonal incidence of sucking pests of yard long bean during *Kharif* and *Rabi* 2018-19

Kharif				***Rabi***			
Month	**Week**	**MSW**	**Average no. of mite\2.5 cm^2 leaf**	**Month**	**Week**	**MSW**	**Average no. of mite\2.5 cm^2 lea**
August	III	34	0.00	**December**	IV	52	0
	IV	35	0.00	**January**	I	1	0
September	I	36	0.00		II	2	0
	II	37	8.36		III	3	1.69
	III	38	13.32		IV	4	4.86
	IV	39	8.12		V	5	7.37
October	I	40	5.36	**February**	I	6	12.23
	II	41	5.02		II	7	18.82
	III	42	7.85		III	8	11.21
	IV	43	11.35		IV	9	7.68
	V	44	12.30	**March**	I	10	17.23
November	I	45	13.70		II	11	21.50
	II	46	7.80		III	12	11.42
	III	47	9.20		IV	13	15.07
	IV	48	12.98				
Mean			**12.98**	**Mean**			**9.22**

Note: MSW; Mean Standard Week

Table 3: Correlation and regression values for incidence of mite population and weather parameters (*Kharif* and *Rabi*, 2018-19)

Sucking pests	**Correlation coefficient (r)**					**Co-efficient of determination (r2)**	**Regression Equation**
	Meteorological parameters						
	Rainfall (X_1)(mm)	**Max.Temp. (X_2) (^{0}C)**	**Min.Temp. (X_3) (^{0}C)**	**RH-I (X_4) (%)**	**RH-II (X_5) (%)**		
Kharif	-0.238	0.696**	-0.258	-0.302	-0.695**	0.656	$Y= -19.129-0.037X_1+0.164X_2-0.415X_3-0.384X_4-0.360X_5+3.516$
Rabi	-	0.762*	-0.709*	-0.420	0.321	0.757	$Y = -32.036+1.249X_1-2.169X_2-0.626X_3+0.260X_4+4.637$

*Correlation is Significant at the 0.05 level; ** Correlation is Significant at the 0.01 leveL

There was a significant positive correlation between red spider mite population and maximum temperature (r = 0.762) and minimum relative humidity (r = 0.321). The mite population showed non-significant negative correlation with maximum relative humidity (r = -0.420) and minimum temperature (r = -0.709). The equation obtained when the data subjected to multiple linear regression analysis was $Y = -32.036 + 1.249X_1 - 2.169X_2 - 0.626X_3 + 0.260X_4 + 4.637$. The value of the coefficient of determination R^2 revealed that the seasonal incidence of bean aphid was influenced by weather parameters to the extent of 75.70 per cent (Table 3).

The present findings are supported by the reports of Kataria and Kumar (2016) studied the seasonal incidence of mites in beans crop. The result indicated that the mites population showed a positive correlation with maximum temperature and negative correlation with minimum temperature, relative humidity and rainfall. Hence, it can be concluded that both temperature and relative humidity largely influence incidence mite population.

Study on efficacy of selected insecticides against red spider mite in yard long bean

The experiment was carried out at Bavikere, UAHS, Shivamogga during 2018-2019. The experiment laid out in randomized completely block design with nine treatments and three replications. The details of treatments and dosages are presented in table1. Two sprays of insecticides were given at 15 days interval during the study period. The first spray was initiated when the crop was uniformly infected with pest. The data on the mite population were recorded and presented below.

Results of the experiment revealed that, there was no significant difference among the treatments with respect to number of mites per 2.5 cm^2 leaf area before imposition of treatments. The mean population varied from from 3.09 to 21.47 mites per 2.5 cm^2 leaf area, respectively.

The mean mite population after the of spraying insecticides across the treatments indicated that least population of mites was recorded in spiromecifen 22.9 SC of 3.09 mites per 2.5 cm^2 leaf area followed by fenazaquin 10 EC, diafenthiuron and chlorfenapyr 10 EC with the population of 3.66, 4.64 and 5.71 mites per 2.5 cm^2 leaf area, respectivley. Whereas untreated control recording the highest mite population of 21.47 mites per 2.5 cm^2 leaf area (Table 4).

Among the treatments, highest per cent reduction of 85.60 per cent was recorded in the treatment spiromecifen 22.9 SC followed by fenazaquin10 EC (82.95 %) and diafenthiuron 50 EC (78.38 %) when compared to untreated control. Lowest per cent reduction of 51.79 per cent was showed by azadirachtin 10,000 ppm (Table 4).

The present findings were in association with Roopa (2005) who reported that among different pesticides under test, spiromesifen (0.024%) and diafenthiuron (0.075%) were highly effective against all stages of spider mite on brinjal. Aguir *et al.* (1993) who reported that diafenthiuron was highly effective against mites. Valunj *et al*. (1999) revealed that chlorfenapyr was recorded most effective treatment against mite.

Anandkumar *et al.* (2003) recorded the lowest population of mites, *T. urticae* in diafenthiuron at 875 g per ha (5.88/leaf) treated brinjal plot which was followed by fenazaquin 500 ml per ha (8.99/leaf) treated plot.

Thus, it is concluded that all the studied insecticides proved effective against the leafhopper but the toxicity studies of the insecticides was observed from maximum to minimum in the following order, Spiromecifen > Fenazaquin > Chlorfenapyr > Diafenthiuron > Imidacloprid > Acetamaprid > Acephate > Azadirachtin.

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Table 4: Efficacy of different insecticides against mites, *Tetranychus urticae* during 2018-19 (Pooled Data)

Figures in parentheses are √x + 0.5 transformed values; Means in the columns followed by the same alphabet do not differ significantly by DMRT (P = 0.05); DBS-Day before spray; DAS-Days after spray

Sl. No.	Treatments	Dosage (g or ml per ltr.)	Mean no. of mites per 2.5 cm^2 leaf											Per cent reduction over control
			First spray					Second spray						
			1DBS	1DAS	3DAS	5DAS	7DAS	1DBS	1DAS	3DAS	5DAS	7DAS	Mean	
1	Acetamiprid 20 SP	0.3g/ ltr	14.75 (3.84)	10.62 (3.24)^{bc}	8.65 (2.93)^{bc}	6.50 (2.54)^{cd}	5.89 (2.42)^{bc}	12.82 (3.57)^{bc}	10.99 (3.31)^{cde}	8.54 (2.92)^{cde}	7.39 (2.71)^{cde}	6.87 (2.62)^{cd}	**8.19**	**61.85**
2	Imidacloprid 17.8 SL	0.5ml/ltr	15.30 (3.91)	10.31 (3.21)^{bcd}	8.12 (2.85)^{bc}	6.10 (2.45)^{d}	5.25 (2.28)^{c}	12.10 (3.47)^{bcd}	10.12 (3.18)^{bcd}	7.68 (2.77)^{bcd}	6.89 (2.62)^{bcd}	5.80 (2.40)^{c}	**7.52**	**64.97**
3	Chlorfenapyr 10 EC	1.5ml/ltr	14.88 (3.85)	8.10 (2.82)^{cde}	6.65 (2.57)^{cd}	4.35 (2.08)^{e}	3.98 (2.99)^{c}	9.60 (3.07)^{de}	7.70 (2.77)^{efg}	5.82 (2.41)^{efg}	4.99 (2.23)^{ef}	4.10 (2.02)^{e}	**5.71**	**73.40**
4	Diafenthiuron 50 WP	1.5g/ltr	15.72 (3.94)	7.23 (2.68)^{de}	5.65 (2.37)^{de}	3.92 (1.97)^{ef}	2.48 (1.55)^{d}	10.75 (3.27)^{cde}	6.06 (2.45)^{def}	4.57 (2.13)^{def}	3.98 (1.99)^{def}	3.25 (1.80)^{de}	**4.64**	**78.38**
5	Spiromesifen 22.9 SC	0.5ml/ltr	15.84 (3.97)	6.20 (2.48)^{e}	4.37 (2.09)^{e}	2.79 (1.66)^{f}	1.10 (1.05)^{e}	8.10 (2.84)^{e}	3.87 (1.96)^{g}	3.12 (1.76)^{g}	2.19 (1.47)^{g}	1.14 (1.06)^{f}	**3.09**	**85.60**
6	Fenazaquin 10 EC	2.0ml/ltr	14.92 (3.86)	6.74 (2.59)^{e}	4.89 (2.21)^{de}	3.07 (1.75)^{ef}	1.84 (1.33)^{de}	8.95 (2.98)^{e}	4.87 (2.20)^{fg}	3.59 (1.90)^{fg}	2.76 (1.64)^{fg}	1.57 (1.24)^{f}	**3.66**	**82.95**
7	Azadirachtin 10,000 ppm	2.0ml/ltr	15.10 (3.88)	12.95 (3.59)^{ab}	10.74 (3.27)^{b}	8.86 (2.97)^{b}	7.17 (2.67)^{b}	13.97 (3.73)^{b}	12.35 (3.51)^{b}	11.52 (3.39)^{b}	9.98 (3.15)^{b}	10.25 (3.20)^{b}	**10.35**	**51.79**
8	Acephate 75 SP	1.5g/ltr	15.62 (3.95)	12.13 (3.46)^{b}	9.95 (3.14)^{b}	8.10 (2.84)^{bc}	6.28 (2.50)^{dc}	13.19 (3.62)^{bc}	11.68 (3.41)^{bc}	10.21 (3.19)^{bc}	9.54 (3.08)^{bc}	8.62 (2.93)^{bc}	**9.56**	**55.47**
9	Control	-	15.56 (3.94)	15.87 (3.98)^{a}	18.92 (4.33)^{a}	20.12 (4.48)^{a}	21.48 (4.62)^{a}	22.01 (4.69)^{a}	22.10 (4.70)^{a}	23.44 (4.84)^{a}	24.15 (4.91)^{a}	25.68 (5.06)^{a}	**21.47**	-
	SEM±	-	NS	1.12	0.88	0.70	0.70	0.93	0.96	0.84	0.85	0.73	-	-
	CD (P=0.05)	-	NS	3.36	2.64	2.10	2.12	2.79	2.90	2.54	2.55	2.20	-	-
	CV (%)	-	8.4	10.66	9.15	8.25	9.15	7.91	10.19	9.81	10.48	9.85	-	-

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