Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(5): 795-799

Received: 13-07-2017
Accepted: 14-08-2017

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Population dynamics and management of yellow mite, *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae) infesting gerbera under protected cultivation

Soumita Pal and Krishna Karmakar

Abstract
The present experiment was conducted in an experimental unit, at Horticultural Teaching Farm, of Bidhan Chandra Krishi Viswavidyalaya during August to December in the year 2015 to study the population dynamics of yellow mite and its management on the susceptible cultivar Jaffana. It appears in a devastating form causing curling, twisting and malformed growth of the plants yielding deformed flowers. Mites colonize and feed on the young leaves and flowers and cause distortion. The females lay eggs under surface of leaves and all the active stages viz., larvae and adults were observed to suck cell sap. As a result of continuous feeding, leaf margins to curl, brittle and shriveled. The infested leaves become cupped, curled, dwarfed, and flowers become discoloured and deformed. The mite population is significant and directly correlated with prevalent temperature and relative humidity and also sunshine hours having a positive role to build up the population. Application of sulphur @ 1600gm ai/ha, dicofol @277.5 gm a.i/ha, diafenthiuron @ 800gm a.i/ha, fenazaquin @ 100 gm a.i/ha and spiromesifen @ 500 gm a.i/ha registered highest mite mortality while ethion was least effective to the mite species.

Keywords: Yellow mite, *Polyphagotarsonemus latus* (Banks), population dynamics, weather factors, acaricides, susceptible

1. Introduction

Gerbera is one of the most popular flower crops grown and used as a cut flower in India. It is a very beautiful and attractive flower of 3 to 5-inch diameter with vibrant colour combinations of red, orange, yellow, pink, white etc. and of different shapes [13]. It is the fifth most used cut flower in the world after rose, carnation, chrysanthemum and tulip [1]. Major Gerbera cut flower producing states in India are Arunachal Pradesh, Assam, Goa, Haryana, Himachal Pradesh, Karnataka, Meghalaya, Mizoram, Telangana, Uttarakhand [8]. India ranked second largest position on the basis of area under floriculture next to China with the production of 1729.2 MT loose flowers and 76731.9 million of cut flowers in 2012-13 [10]. Gerbera is infested by numbers of insect and non-insect pests including insects, mites, nematodes, snails, mice etc. from seedling stage to harvest [11]. Mostly the leaves and flower parts are affected by these pests. Important insects attacking gerbera flowers are aphid, whitefly, thrips, leaf miner etc. Important mite species those attack gerbera includes spider mite *Tetranychus urticae* Koch, Cyclamen mite, *Phytonemus pallidus* (Banks) and yellow mite, *Polyphagotarsonemus latus* (Banks). The yellow mite, *Polyphagotarsonemus latus* (Banks) was observed as a major and serious pest affecting gerbera in West Bengal throughout the year under polyhouse condition with maximum infestation takes place during the hot and humid period of the year. It appears in devastating form causing curling, twisting and malformed growth of the plants yielding deformed flowers. The yellow mite usually attacks on the ventral surface of small terminal tender leaves and on the medium sized younger leaves. The tiny yellow mite colonizes and feeds on the ventral surface of leaf and flowers also when their population attains maximum they may come to the upper surface of leaves even and cause severe distortion. Female lays the eggs on the ventral surface of leaves [11]. Broad mites or yellow mites are cell feeders and use their delicate stylet like chelicerae for piercing and sucking the cell content from the epidermal layer of the young leaves causing leaf margins to curl and the leaves become brittle, shriveled and puckered [9]. The infested leaves become cupped, curled, dwarfed, and thickened. Leaves and flowers become discolored, bronzed, or stiff. Internodes may be short, giving plants a stunted or tufted appearance and the mite injects toxins even during their feeding [3, 7, 18]. The information regarding the varietal performance of different gerbera cultivars against yellow mite and scheduling its management strategy under Gangetic Basin of West Bengal has not been conducted. Therefore, considering the importance of the crop and severity of yellow mite infestation on a regular basis, the present investigation was carried out with the objectives to i) study the population dynamics of the yellow mite species on susceptible cultivar Jaffana for its monitoring and ii) development of management strategy against the mite under polyhouse condition.

2. Materials and Methods

2.1 Study period and location

The experiment was carried out at Horticultural Teaching Farm, of Bidhan Chandra Krishi Viswavidyalaya located at Mondouri, Nadia, West Bengal during 2015-2016. The experimental site is geographically located at 22°56'32"N latitude and 88°30'51"E longitude and at an elevation of 9.75 meters above mean sea level and the land are referred as fertile, loamy soil with flat table top topography under Gangetic Basin of West Bengal.

2.2 Relationship of population dynamics of mite with different abiotic factors

For studying the population dynamics of the mite, the most susceptible cultivar Jaffana was selected. The experiment was laid out in a completely randomized design and gerbera seedlings were transplanted in the plots of 15m × 6m, with 3 replications for the variety under polyhouse condition. For recording data on mite population 10 plants from the variety was considered in each replication and from each of the selected plants, a leaf was plucked to estimate the mean mite population. The leaves were taken to the laboratory by wrapping within closed mouth polypropylene packets stored in an ice box. A four sq. cm. block made of iron wire was used and it was placed on three different spots randomly on the ventral surface of the representative leaf and then the population was counted under stereo zoom binocular microscope. During the study, the population of post embryonic stages was measured and correlated with different abiotic parameters of environment like maximum temperature, minimum temperature, mean temperature, maximum relative humidity, minimum relative humidity, mean relative humidity and sunshine hour recorded under green house condition. Multiple regression equations were also developed by multiple regression analysis.

2.3 Selection of chemical acaricide molecules for management of yellow mite

The most susceptible gerbera variety Jaffana was considered for evaluating the efficacy of different acaricides molecules against the yellow mite where subsequently two rounds of sprays were applied to find out the efficacy of chemical acaricides against mite. Eight acaricide molecules like Dicofol 18.5 EC, Diafenthiuron 80WP, Sulphur 80 WP, Prophenophos 50 EC, Spiromesifen 5 EC, Fenazaquin 10 EC, Ethion 50EC and Chlorfenapyr 10 SC (Table 1) were selected for evaluating their efficacy against the yellow mite. The experiment was conducted in plots of 5m × 4.5m with three replications for each of the treatments. For each chemical treatment, 30 numbers of plants were considered and these were planted in 10 different lines of 5m × 0.5m. Two rounds of sprays were applied at 14 days interval. Post embryonic stages of yellow mite were recorded from each of the replicated plots of each treatment as pre-treatment count and there after the mite population count was taken at 1, 3, 5 and 7 days after application of treatment. The mite population was counted under a binocular microscope in the laboratory as described earlier. The count data of post embryonic stages of yellow mite before and after spraying with different formulations of acaricides had been used to work out the corrected per cent mortality using the formula:

Percent reduction = $[1 - (T_a \times C_b) / (T_b \times C_a)] \times 100$

Where, T_a = Population in treated plants after treatment, C_b = Population in treated plants before treatment, T_b = Population in control plots after treatment, C_a = Population in control plots before treatment.

2.4. Statistical analysis

The corrected per cent mortality data of adult yellow mite was taken at different dates after spraying with different pesticides and it was then transformed using Arcsine transformation. Once the transformation had been made, the transformed data was then subjected to CRD analysis and testing for the significance of treatments was made. DMRT [Duncan Multiple Range Test] was done to compare the means.

3. Results

3.1 Damage symptom due to attack of yellow mite

In the present study, yellow mite was found to infest the ventral surface of the young soft apical leaves. The females were observed to lay eggs mainly under surface of young apical leaves. The male carried the quiescent female to the apical leaves for shifting colony. All the active stages viz., larvae and adults were observed to suck cell sap from the under surface of leaves and from flower buds. As a result of continuous feeding, leaf margins to curl and were become brittle, shriveled and puckered infested leaves become cupped, curled, dwarfed, and thickened. Leaves and flowers become discolored, bronzed, or stiff.

3.2 Role of abiotic factors on population dynamics of mite

It was revealed from the Table 2 that a significant positive correlation was established between mite population and maximum temperature, minimum temperature, and average temperature and the correlation values were highly significant in case of maximum and average temperature and significant in case of minimum temperature and the values were 0.745, 0.682 and 0.594 respectively. Likewise, the results revealed that there was positive correlation existed between mite population and maximum relative humidity, mite population, and minimum relative humidity and mite population and average relative humidity. The correlation values were 0.596, 0.429 and 0.522 respectively which were significant in case of maximum and average relative humidity but non-significant in case of minimum relative humidity. The correlation between mite population and sun shine hour were positive and it was 0.325 which was non-significant. From multiple regression analysis (Table 3), equation was developed like Y (Mean yellow mite population per leaf) = -156.266+3.846 (Max Temperature)-0.467 (Min Temperature) +2.128 (Max RH)-1.129 (Min RH) +0.085 (Sunshine Hour). We can say only intercept wss significant in the regression equation above defined.

3.3 Bioefficacy of acaricides

The result of management experiment revealed after two round spray that all the treatments were superior to control. It was observed application of sulphur @ 1600gm ai/ha was very promising and gave the best result for maintenance of low mite population with 99.98% mortality followed by dicofol @277.5 gm a.i/ha that resulted in 99.97% mite mortality; diafenthiuron @ 800gm a.i/ha showed 99.96% mite mortality followed by fenazaquin @ 100 gm a.i/ha and spiromesifen @ 500 gm a.i/ha rendered 98.94% and 95.37% mortality respectively (Table 4). The acaricide molecule, ethion @ 1ml/lt registered the least mortality (47.72%).

4. Discussion

Broad mite attack was found worldwide like in India, Ceylon (called as yellow tea mite), Bangladesh (called as yellow jute mite), Rummania (called as broad spider) and also on various crops viz., Jute, Cotton, Zinia, Marigold, Dalhia, Datura, Amaranthus, cluster-bean, chilli, potato, tomato, brinjal, cucurbits, tea, cowpea, sowrd-bean, lablab, dew-gram, horse-gram, green-gram, hollyhock, kidney bean, sesame and thorn apple [5]. In West Bengal, it was seen to cause devastating damage in chilli, jute, cowpea, Solanum, Datura and *Ludwigia parviflora*, sesame, dalhia, marigold, *Phaseolus moongo* [19]. It has been reported that 60 plant families were attacked by the yellow mite, *P. latus* [4].

The occurrence of yellow mite and its symptoms of infestation were reported from gerbera [17] and also in other related plants like in Begonia [20], Dahlia and Marigold [19, 24]. Due to attack of *P. latus* 100% damage was noted on sweet peppers and severe damage was found on eggplants, datura, peepers and gerbera were severely damaged under screen house condition [22]. On the cultivated species of jute *Corchorus capsularis* and *Corchorus olitorius* in Bangladesh, all stages of the mites were found on young leaves of the plants and as a result of infestation the leaves curled down, colour changed to coppery to purplish and finally dried up and fall off prematurely [15]. *Polyphagotarsonemus latus* caused different types of physical deformities like thickening, brittleness and shortening, twisting, curling and crumpling of young leaves. Midribs of young infested leaves bent in a Zig-Zag fashion; ventral surface become silvery, petioles of mature leaves elongated and plant became stunted with the appearance of rosette symptoms [19].

In tropical and subtropical areas, the broad mite reproduces throughout the year and in temperate regions, it occurs in the green houses as the mite can't tolerate severe cold in the field [16]. The population level of yellow mite was directly proportional to the temperature and inversely proportional to precipitation on Sicilian lemon crop and population attained in peak during December - January (1995 and 1996) and October - November (1997) [28]. The increase of population of *P. latus* influenced by temperature and growth conditions of plants [21]. The population dynamics was studied under green house condition when both RH and temperature were recorded high and probably due to this reason mite population was found higher and gradually it was found decreasing when temperature tend to become lower to some extent and RH was observed to decline with the weather change. From the multiple regression analysis, it can be concluded that the data of weather parameters altogether contributed 66% on mite population density. These results were same as the previous result where temperature was significantly correlated with the incidence of *P. latus* and relative humidity was positively correlated with the incidence of *P. latus* [27] and a combination of warm temperature, high relative humidity and low light intensity are the optimum environmental condition for profuse build up of tarsonemid mite species [14]. Correlation between meteorological variables and incidence of yellow mite on potato was done and temperature was significantly correlated with the incidence of mite [25].

In the present studies, bio-efficacy of different acaricidal molecules was assessed against post embryonic stages of yellow mite. Fenazaquin provided effective control and was also found eco-friendly in nature being selective in action sparing major bio-control agent like *Amblyseius* sp. [26]. Chlorfenapyr at 100 g ai/ha gave greater than 80% control after 3, 6, 9 and 12 days [1]. Among nine acaricides dicofol (0.074%) and Wettable sulphur were the most effective against all life stages of yellow mite and mortality increased over a period of 14 days [17]. Dicofol was the most effective treatment against *Polyphagotarsonemus latus* [23]. Different molecules used to manage *Polyphagotarsonemus latus* (Banks) and Diafenthiuron (800 g a.i. /ha) showed the best efficacy against motile stages of yellow mite [2].

Table 1: Showing different chemicals (Treatments) and their concentration used

Treatment	Chemical Name	Trade Name	Formulation	Mode of action	Doses in gm a.i./ ha	Doses used
T1	Dicofol	Kelthane	18.5EC	Nerve poison	277.5	1.5 ml/lit
T2	Diafenthiuron	Pegasus	80WP	Inhibitors of oxidative phosphorylation,	800	1 gm/lit
T3	Sulfur	Sulfex	80WP	-	1600	2 gm/lit
T4	Profenophos	Carina	50EC	Acetylcholine esterase Inhibitors	500	1 ml/lit
T5	Spiromesifen	Oberon	5EC	Inhibitors of lipid synthesis	50	1 ml/lit
T6	Fenazaquin	Magister	10EC	Mitochondrial complex I electron transport inhibitors	100	1 ml/lit
T7	Ethion	Promite	50EC	Acetylcholine esterase Inhibitors	500	1 ml/lit
T8	Chlorfenapyr	Inteprid	10SC	Uncouplers of oxidative phosphorylation via disruption of proton gradient	100	1 ml/lit
T9	Control	-	-	-	-	-

Table 2: Relationship between mean yellow mites population with different abiotic factors in gerbera under polyhouse condition at Mounduri, BCKV, West Bengal.

Date of obs.	Mean mite population/4 sq. cm leaf area	Maximum Temperature	Minimum Temperature	Mean Temperature	Maximum Relative Humidity	Minimum Relative Humidity	Mean Relative Humidity	Sunshine Hour(hour/day)
24.9.2015	**9.63**	**27.00**	**25.00**	**26.00**	**79.00**	**77.00**	**78.00**	**3.10**
28.9.15	18.93	28.00	28.00	28.00	80.00	78.00	79.00	9.30
2.10.15	27.27	32.00	30.00	31.00	86.00	80.00	83.00	7.10
6.10.15	36.77	34.00	32.00	33.00	87.00	85.00	86.00	7.10
10.10.15	43.20	30.00	28.00	29.00	87.00	83.00	85.00	6.60
14.10.15	47.83	30.00	28.00	29.00	95.00	93.00	94.00	4.40
18.10.15	56.07	34.00	32.00	33.00	97.00	93.00	95.00	7.90
22.10.15	64.10	33.00	31.00	32.00	95.00	91.00	93.00	9.10
26.10.15	70.57	34.00	32.00	33.00	94.00	90.00	92.00	9.10
30.11.15	60.43	30.00	28.00	29.00	85.00	77.00	81.00	5.70
5.11.15	48.37	30.00	22.00	26.00	90.00	88.00	89.00	6.90
9.11.15	35.50	29.00	25.00	27.00	89.00	77.00	83.00	6.50
13.11.15	28.03	25.00	23.00	24.00	80.00	76.00	78.00	7.00
17.11.15	20.70	26.00	24.00	25.00	86.00	84.00	85.00	0.30
21.11.15	11.97	24.00	20.00	22.00	94.00	92.00	93.00	9.00

Table 3: Regression Analysis

Particular	Regression Statistics
Multiple R	0.813306
R Square	0.661466
Adjusted R Square	0.473391
Standard Error	13.93759
Observations	15

Table 4: Efficacy of different acaricide molecules against yellow mite, *Polyphagotarsonemus latus* (Banks) in gerbera under Polyhouse condition at Mounduri, BCKV, West Bengal.

Treatment	Dose	Pre-treatment count of mite population		Mean per cent mortality of yellow mite at different days after spray (DAS)								Mean		Pooled Mean
				1 DAS		3 DAS		5 DAS		7 DAS				
		1st spray	2nd spray	1st spray	2nd spray	1st spray	2nd spray	1st spray	2nd spray	1st spray	2nd spray	1st spray	2nd spray	
Dicofol 18.5EC	1.5 ml/lit	20.16	5.40	99.99 (89.41^{d})	99.95 (88.80^{d})	99.99 (89.41^{e})	99.95 (88.80^{e})	99.99 (89.41^{e})	99.95 (88.80^{d})	99.99 (89.41^{e})	99.95 (88.80^{d})	99.99 (89.46f)	99.95 (88.80^{e})	99.97 (89.11^{e})
Diafenthiuron 80 WP	1 gm/lit	22.96	2.86	99.99 (89.45^{d})	99.94 (88.65^{d})	99.99 (89.45^{e})	99.94 (88.65^{e})	99.99 (89.45^{e})	99.94 (88.65^{d})	99.99 (89.45^{e})	99.94 (88.65^{d})	99.99 (89.45^{f})	99.94 (88.65^{e})	99.96 (89.04^{e})
Sulfur 80 WP	2 gm/lit	24	8.73	99.99 (89.46^{d})	99.97 (89.07^{d})	99.99 (89.46^{e})	99.97 (89.07^{e})	99.99 (89.46^{e})	99.97 (89.07^{d})	99.99 (89.46^{e})	99.97 (89.07^{d})	99.99 (89.46^{f})	99.97 (89.07^{e})	99.98 (89.26^{e})
Profenofos 50 EC	1 m/lit	24.93	28.43	60.18 (50.90^{b})	82.39 (65.22^{c})	57.67 (49.44^{c})	75.39 (60.29^{d})	53.95 (47.29^{c})	60.9 (51.32^{c})	43.14 (41.08^{b})	56.34 (48.67^{bc})	53.73 (47.19^{c})	68.75 (56.43^{c})	61.24 (51.81^{c})
Spiromesifen 5 EC	1 ml/lit	23.20	6.43	99.99 (89.45^{d})	99.96 (88.91^{d})	99.99 (89.45^{e})	99.96 (88.91^{e})	99.99 (89.45^{e})	99.96 (88.91^{d})	99.99 (89.45^{e})	63.09 (52.61^{c})	99.99 (89.45^{f})	90.74 (81.07^{d})	95.37 (85.26^{e})
Fenazaquin	1 ml/lit	24.66	8.53	99.99 (89.47^{d})	99.97 (89.05^{d})	99.99 (89.47^{e})	99.97 (89.05^{e})	99.99 (89.47^{e})	99.97 (89.05^{d})	91.66 (73.25^{d})	99.97 (89.05^{d})	97.91 (86.11^{e})	99.97 (89.05^{e})	98.94 (87.58^{e})
Ethion 50 EC	1 ml/lit	23.03	30.56	53.74 (47.17^{b})	63.8 (53.04^{b})	46.9 (43.24^{b})	53.57 (47.07^{b})	42.17 (40.52^{b})	42.89 (40.93^{b})	39.28 (38.83^{b})	49.91 (44.98^{b})	45.52 (42.43^{b})	49.91 (44.98^{b})	47.72 (43.71^{b})
Chlorfenapyr 10SC	1 ml/lit	24.23	13.10	79.09 (62.82^{c})	66.96 (54.94^{b})	83.97 (66.43^{d})	60.75 (51.24^{c})	85.03 (67.27^{d})	54.36 (47.53^{bc})	83.71 (66.23^{c})	43.32 (41.18^{bc})	82.95 (65.75^{d})	56.35 (48.75^{b})	69.65 (57.25^{d})
Control		23.60	42.23	0.01 (0.59^{a})	0.01 (0.44^{a})	0.01 (0.59^{a})	0.01 (0.44^{a})	0.01 (0.59^{a})	0.01 (0.44^{a})	0.01 (0.59^{a})	0.01 (0.44^{a})	0.01 (0.59^{a})	0.01 (0.44^{a})	0.01 (0.52^{a})
Over all Significance of Varieties				Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
Error Mean Sum of Squares				8.61	5.95	2.87	4.39	2.10	18.54	17.78	95.21	13.07	57.30	47.02
S.E m(±)				1.69	1.40	0.97	1.21	0.83	2.48	2.43	5.63	1.47	3.09	1.97
S.E d(±)				2.39	1.99	1.38	1.71	1.18	3.51	3.44	7.96	2.08	4.36	2.79
C D at 5 per cent level of significance				5.84	4.87	3.38	4.18	2.89	8.59	8.41	19.48	4.75	9.94	6.32

5. Conclusion

These findings indicated that the mite, *P. latus* prefers young, soft, premature and apical leaves and mite infestation is more during hot and humid condition, though in poly house condition mite population remain throughout the year in some extent. So, for controlling mite infestation acaricides should be sprayed on the top portion of gerbera plant and it is best if the acaricides can be sprayed on the ventral surface of leaves directly as it is the main habitat region of the yellow mite. Application of sulphur @ 1600gm ai/ha, dicofol@277.5 gm a.i/ha, diafenthiuron @ 800gm a.i/ha, fenazaquin @ 100 gm a.i/ha and spiromesifen @ 500 gm a.i/ha may be recommended as need based application. It should not be sprayed until the pest population will reach the ETL level because indiscriminate use of acaricides may also kill the predatory mite fauna associated with it and destroy the natural biological control.

6. Acknowledgements

With giving special thanks to the Vice Chancellor, Director of Research and In-Charge, AICRP on Floriculture, Bidhan Chandra Krishi Viswavidyalaya, for extending help and support and also for providing fund and infrastructure facilities.

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