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Seasonal incidence of spider mite in gerbera and its management under protected cultivation

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ABSTRACT

The current study was conducted in the experimental plot of Division of Floriculture & Landscaping Architecture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K), Shalimar from March - February (2020-2021) under protected cultivation. The mite incidence on leaves reached the peak (1.75 mites/leaf) in 24th Standard Meteorological Week (SMW)-June when the mean maximum temperature was 33.3°C while on flowers, peak (13.95 mites/flower) was obtained in 27th SMW (July) at a corresponding maximum mean temperature of 37.7°C. The correlation studies between mite population and weather parameters revealed a positive and highly significant correlation of mites with temperature (minimum and maximum) whereas negative and highly significant relationship with maximum relative humidity was observed. Bio-efficacy of various treatments against mites revealed spiromesifen 5%EC@1ml/L to be most efficient followed by chlorfenapyr 10%SC @1ml/L. However, fipronil 5% SC @ 1 ml/L showed the lowest efficacy against mites.

Key words: *Gerbera jamesonii*, mites, seasonal incidence, protected cultivation.

INTRODUCTION

In India, the floriculture sector has emerged as an economically viable diversification, attracting significant interest from entrepreneurs. The industry is increasing at a rate of 15-20% per year (Bhat *et al.,* 3). Jammu & Kashmir has a good temperature and rich natural resources such as soil, water, and topographic diversity that makes it ideal for cultivating practically all kinds of economically valuable flowers. In 2019-20, the land under floriculture in J&K has been estimated as 279.15 ha, with a loose flower yield of around 2065.62 MT (Anonymous,1).

Gerbera (*Gerbera jamesonii* Bolus) is a commercially important flower crop growing in Kashmir valley, with high demand in the floriculture industry, ranking it fifth amongst top ten cut flowers globally (Prodhan *et al.,* 5). The single most important constraint in gerbera cultivation in Kashmir conditions is the attack of various insect pests and mites. The two-spotted red spider mite, *T. urticae* (Acari: *Tetranychidae*) lives in colonies on the undersurface of leaves and forms webbing structures. The leaves become chlorotic due to the sucking of cell contents by the mite. The quality and quantity of the flower production is affected (Shah and Shukla, 7). Mite attack is a major impediment to successful gerbera cultivation. Development of a scientific management strategy for Kashmir conditions has received little attention. Present study was conducted to examine the seasonal incidence and assessment of the efficacy of various treatment molecules against mites.

MATERIALS AND METHODS

A field study was done using the gerbera variety 'Felicks'. Planting was done on 13th March, 2020 in polyhouse at a spacing of 35 cm× 40 cm in the experimental field of the Division of Floriculture and Landscaping Architecture, Faculty of Horticulture (FOH), SKUAST-K, Shalimar. Incidence of mites was recorded from March, 2020 to February, 2021 at weekly intervals. Ten plants were selected randomly for taking the observations. A hand lens (10X) was used for taking observations from three fully matured flowers which represented the top, middle and bottom regions on each plant. The influence of the weather parameters i.e., maximum temperature (Tmax) and minimum temperature (Tmin) and maximum relative humidity (RHmax) and minimum relative humidity (RHmin) on the incidence of mite pests of gerbera was assessed during the experimental study. The temperature and RH were recorded on daily basis using digital temperature and humidity meter. Simple correlation analysis between the incidence of mite pests with temperature and RH under polyhouse conditions was worked out. The status of natural enemies was also recorded (Plate 1)

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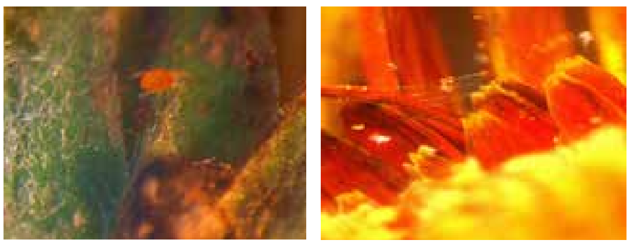
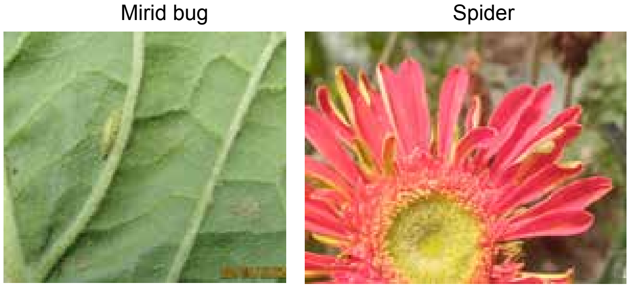
Typical mite infestation (webbing) on leaf and flower



Microscopic image of mite and mite eggs in flower bud

Mirid bug Spider



Larva and pupa of syrphid fly

Plate 1. Severe mite infestation and natural enemies recorded on gerbera.

For managing mites, polyhouse of dimensions 17m × 5.16m was divided in three blocks of equal size (17m × 1.52m) each representing a replication. Each block was further divided into ten plots each of size 1.21m × 1.52m. Each plot represented a treatment and consisted of five plants grown at a recommended spacing of 35cm × 40cm. The experiment was set up in Randomized Complete Block Design (RCBD) with a total of 10 treatments comprising of one botanical, one entomopathogen and seven new molecular insecticides including an untreated control and were replicated thrice (Table 1). The mite population was counted one day prior to the spray followed by the two rounds of spray that were applied at 14 days interval. Observations after both sprays were recorded at 1, 3, 7 and 15 days after spraying (DAS) from randomly selected three plants of each treatment (3 leaves and 1 flower bud from each plant). Satistical analysis was done using OPSTAT software.

RESULTS AND DISCUSSION

The infestation level of mites on gerbera leaves ranged 0.05 to 1.75 mites/leaf (Fig 1). Initially lower incidence was recorded during 12th SMW (March) which was followed by gradual increase and reached the peak in 24th SMW (June) when the mean maximum temperature was 33.3°C. This was followed by a gradual decline till 42nd SMW (October). No mite incidence was observed from 43rd SMW up to 5th SMW. Afterwards, slight population buildup was observed from 6th SMW (February). The population density of mites on gerbera flowers ranged 0.2 to 13.95 mites/flower (Fig 1). The investigation period started with no mite incidence on the gerbera flowers during 12th and 13th SMW (March) followed by a steady increase in the population levels from 14th SMW (April) reaching the peak incidence in 27th SMW (July) at a corresponding maximum mean temperature of 37.7°C. Following this, the population levels showed a gradual decline till 39th SMW (September). Thereafter, from 40th to 8th SMW, no mite incidence was observed. The results are more or less similar to that of Shelke *et al.* (6). This could be attributable to the favorable abiotic conditions that helped increase in the population of mites. Disappearance of mites from October to February is attributable to significant drop in temperature that led to overwintering. Further, the natural enemies recorded on gerbera are presented in Table 2.

Table 1. Treatment details against mites under polyhouse conditions.

T_1	Azadirachtin 0.03%EC @ 5 ml/L
T_2	Spinosad 45% SC@ 0.5 ml/L
T_3	Chlorfenapyr 10% SC @ 1ml/L
T_4	Emamectin Benzoate5% WG @ 0.5 g/L
T_5	Spiromesifen 5% EC @ 1ml/L
T_6	Acetamiprid 20% SP@ 0.5g/L
T_7	Thiamethoxam 25% WG @ 0.2 g/L
T_8	Fipronil 5% SC @ 1 ml/L
T_9	*Lecanicillium lecani* (1x108 CFU's/ml) @ 2ml/L
T_{10}	Control

Table 2. Natural enemies recorded on gerbera during March, 2020- February, 2021.

Common name	Scientific name	Family	Order
Syrphid flies	*Episyrphus balteatus*	Syrphidae	Diptera
Spider	Unspecified	-	Araneae
Mirid bug	Unspecified	Miridae	Hemiptera
Ladybird beetle	*Coccinella* sp.	Coccinellidae	Coleoptera
Green lacewing bug	*Chrysoperla* sp.	Chrysopidae	Neuroptera

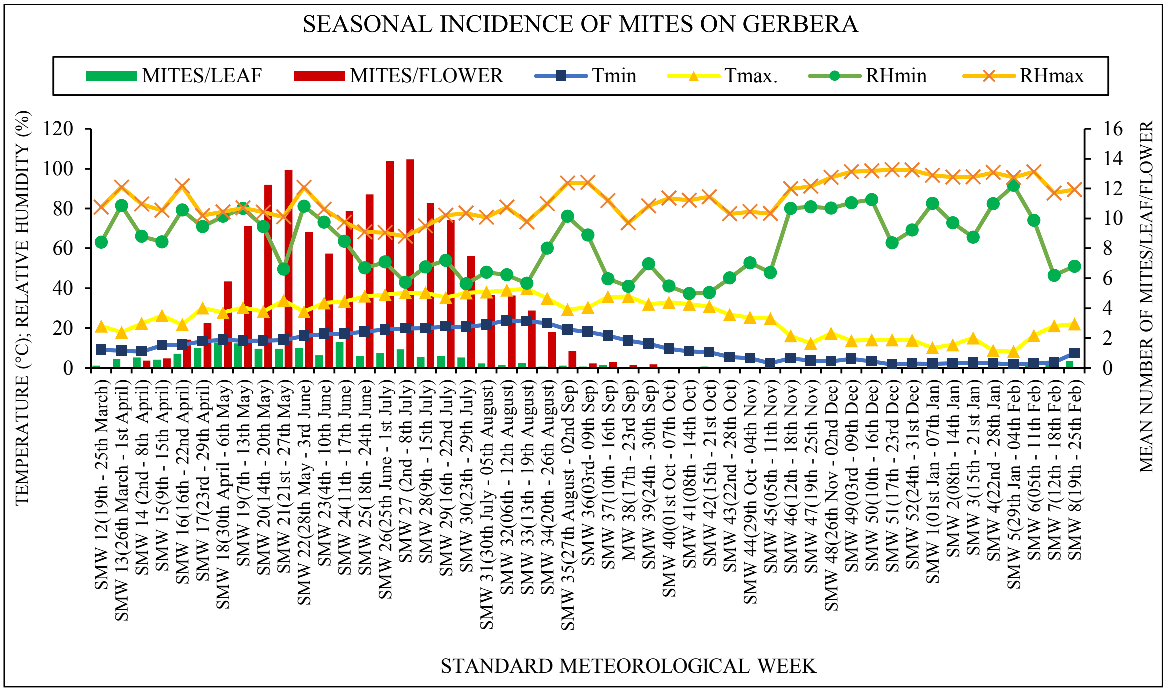


Fig. 1. Seasonal incidence of mites on leaves and flowers in gerbera under protected conditions during 2020-2021.

A significant and positive correlation of mite population on leaves and flowers with minimum and maximum temperature was noticed. Further, a negative and highly significant correlation was observed between maximum relative humidity and mite population on leaves and flowers respectively. Further, regression analysis (R^2) revealed a variation of 59 and 60 per cent in mite population because of weather parameters on leaves and flowers respectively (Table 3). The conclusion is in accordance with findings of Amin *et al.* (2) who also observed that mite populations are positively correlated with minimum and maximum temperature which can be attributed to the fact that when the temperature rises, insect's metabolism speeds up resulting in their increased biological activities including higher food assimilation, higher fecundity and increased production of offspring's. Also, the mite population was observed to be negatively correlated with relative humidity during the current study which commensurate with Shelke *et al.* (6) who also reported similar findings. This could be because of negative effect of high humidity on insect's growth and development.

On gerbera leaves, a pre-treatment count of mites was taken and population density ranged 4.00 to 5.44 mites/leaf, with no significant difference between treatments (Table 4). At 1DAS, T_3 (chlorfenapyr 10% SC @1ml/L) and T_5 (spiromesifen 5% EC @1ml/L) recorded the lowest mite population followed by T_9 (*Lecanicillium lecanii* 1×10^8 CFUs/ml @2ml/L). At 3DAS, T_3 (3.66 mites/leaf) and T_5 (3.66 mites/leaf) proved to be superior over other treatments followed by T_9 (3.89 mites/leaf). At 7DAS, T_5 (3.00 mites/leaf) and T_3 (3.22 mites/leaf) recorded lowest mite population exhibiting non-significant variation with each other. T_4 and T_9 were found to be the next best treatments each recording 3.66 mites/leaf. At 15DAS, T_5 and T_3 recorded the lowest population of 3.00 mites/leaf in each treatment followed by

Table 3. Relationship between mite population and weather parameters (temperature, °C and relative humidity, %) under protected condition.

Pest	Correlation coefficient values (r)				R^2	Multiple Regression Equation
	Temperature (°C)		Relative Humidity (%)			
	Minimum (X_1)	Maximum (X_2)	Minimum (X_3)	Maximum (X_4)		
Number of mites/leaf	0.502**	0.431*	0.062	-0.53**	0.59	$Y=0.48-0.02X_1 +0.04X_2 +0.03X_3 - 0.03X_4$
Number of mites/flower	0.657**	0.598**	-0.178	-0.667**	0.60	$Y=19.97 +0.21X_1 +0.02X_2 +0.11X_3 - 0.31X_4$

*- Correlation is significant at 0.05 level **- Correlation is significant at 0.01 level

Table 4. Bio-efficacy of various treatments against the mites infesting gerbera leaves.

Treatments	Number of mites/leaf (1st spray)					Number of mites/ leaf (2nd spray)				Per cent protection
	1DBS	1DAS	3DAS	7DAS	15DAS	1DAS	3DAS	7DAS	15DAS	
T_1: Azadirachtin 0.03%EC @ 5 ml/L	4.88 (2.42)	4.66 (2.37)	4.11 (2.25)	3.77 (2.18)	3.78 (2.18)	3.55 (2.13)	3.22 (2.05)	2.78 (1.94)	2.55 (1.88)	75.57
T_2: Spinosad 45% SC@ 0.5 ml/L	5.44 (2.54)	5.22 (2.49)	4.88 (2.42)	4.33 (2.30)	4.22 (2.28)	4.11 (2.26)	3.89 (2.21)	3.55 (2.13)	3.22 (2.05)	69.15
T_3: Chlorfenapyr 10% SC @ 1ml/L	4.11 (2.25)	3.89 (2.21)	3.66 (2.16)	3.22 (2.05)	3.00 (2.00)	2.88 (1.97)	2.77 (1.94)	1.89 (1.69)	1.55 (1.59)	85.15
T_4: Emamectin Benzoate5% WG @ 0.5g/L	4.44 (2.33)	4.33 (2.31)	4.00 (2.23)	3.66 (2.15)	3.66 (2.16)	3.00 (2.00)	3.11 (2.02)	2.77 (1.94)	2.22 (1.79)	78.73
T_5: Spiromesifen 5% EC @ 1ml/L	4.00 (2.23)	3.89 (2.21)	3.66 (2.16)	3.00 (2.00)	3.00 (1.94)	2.78 (1.93)	2.66 (1.91)	1.88 (1.69)	0.89 (1.37)	91.47
T_6: Acetamiprid 20% SP@ 0.5g/L	5.11 (2.46)	4.88 (2.42)	4.22 (2.27)	4.00 (2.23)	4.00 (2.23)	3.66 (2.15)	3.55 (2.13)	3.00 (1.99)	2.99 (2.00)	71.36
T_7: Thiamethoxam 25% WG @ 0.2 g/L	4.89 (2.41)	4.66 (2.37)	4.11 (2.25)	3.99 (2.23)	3.89 (2.21)	3.66 (2.16)	3.22 (2.05)	2.89 (1.97)	2.88 (1.97)	72.41
T_8: Fipronil 5% SC @1ml/L	5.22 (2.49)	5.11 (2.47)	4.88 (2.43)	4.33 (2.30)	4.00 (2.23)	3.77 (2.17)	3.66 (2.16)	3.44 (2.10)	3.11 (2.02)	70.21
T_9: *Lecanicillium lecanii* ($1x10^8$ CFU's/ml) @2ml/L	4.22 (2.27)	4.11 (2.26)	3.89 (2.21)	3.66 (2.15)	3.22 (2.05)	2.99 (2.00)	2.89 (1.97)	2.33 (1.80)	1.88 (1.69)	81.99
T_{10}: Control	5.44 (2.53)	6.33 (2.71)	6.44 (2.73)	7.11 (2.84)	8.44 (3.07)	8.55 (3.09)	9.66 (3.26)	10.22 (3.35)	10.44 (3.38)	
C.D ($P \leq 0.05$)	NS	0.24	0.33	0.38	0.41	0.35	0.29	0.35	0.29	
S.E(m)	0.13	0.08	0.11	0.13	0.14	0.12	0.10	0.12	0.10	
C.V.	9.18	5.88	8.20	9.66	10.51	9.37	7.75	9.80	8.51	

DBS- Day before spray, DAS- Days after spray and figures in parentheses are square root transformations and NS- Non-significant

T_9 (3.22 mites/leaf). Post second spray, at 1 and 3 DAS, T_5 had lowest mite population followed by T_3 followed by T_9. At 7 DAS, T_5 (1.88 mites/leaf) recorded the lowest mite population followed by T_3 (1.89 mites/leaf) followed by T_9 (2.33 mites/leaf). At 15 DAS, T_5 excelled over all the treatments recording a population of 0.89 mites/leaf followed by T_3 followed by T_9.

In case of flowers, on 1 DBS, the mite population ranged 6.11 to 9.55 mites/flowers and exhibited non-significant variation among different treatments (Table 5). At 1DAS, lowest population of 5.66 mites/flower was recorded in T_3 (chlorfenapyr 10% SC@1ml/L), T_5 (spiromesifen 5% EC @1ml/L) and T_9 (*Lecanicillium lecanii* [$1×10^8$ CFUs/ml] @2ml/L) followed by T_4 (emamectin benzoate 5%WG @0.5g/L) with 6.33 mites/flower. At 3 DAS, T_5 proved to be superior to other treatments followed by T_3 followed by T_9. At 7 DAS, T_5 recorded the lowest mite population with 4.22 mites/flower followed by T_3 (4.44 mites/flower)

Table 5. Bio-efficacy of various treatments against the mites infesting gerbera flowers.

Treatments	Number of mite/flower bud (1st spray)					Number of mite/flower bud (2nd spray)				Per cent protection
	1DBS	1DAS	3DAS	7DAS	15DAS	1DAS	3DAS	7DAS	15DAS	
T_1: Azadirachtin 0.03%EC @ 5 ml/L	7.22 (2.86)	6.33 (2.70)	5.88 (2.62)	4.89 (2.41)	4.55 (2.34)	3.77 (2.16)	3.22 (2.04)	3.00 (2.00)	2.66 (1.91)	86.84
T_2: Spinosad 45% SC@ 0.5 ml/L	8.22 (3.03)	7.33 (2.87)	7.11 (2.84)	6.44 (2.73)	5.55 (2.56)	4.77 (2.40)	4.66 (2.38)	4.33 (2.31)	4.66 (2.38)	76.95
T_3: Chlorfenapyr 10% SC @ 1ml/L	6.77 (2.78)	5.66 (2.58)	5.22 (2.49)	4.44 (2.33)	3.66 (2.16)	2.78 (1.92)	2.00 (1.72)	1.55 (1.59)	1.33 (1.52)	93.42
T_4: Emamectin Benzoate5% WG @ 0.5g/L	7.22 (2.86)	6.33 (2.70)	5.89 (2.61)	5.22 (2.49)	4.66 (2.37)	4.55 (2.35)	4.11 (2.26)	3.77 (2.18)	2.89 (1.97)	85.70
T_5: Spiromesifen 5% EC @ 1ml/L	6.11 (2.66)	5.66 (2.56)	5.00 (2.44)	4.22 (2.28)	3.44 (2.10)	2.44 (1.85)	1.78 (1.65)	1.33 (1.51)	1.00 (1.40)	95.05
T_6: Acetamiprid 20% SP@ 0.5g/L	8.11 (3.01)	7.11 (2.85)	6.66 (2.77)	5.88 (2.60)	5.11 (2.47)	4.77 (2.39)	4.55 (2.35)	4.33 (2.30)	4.11 (2.26)	79.67
T_7: Thiamethoxam 25% WG @ 0.2 g/L	8.11 (3.02)	6.66 (2.77)	5.89 (2.62)	5.44 (2.53)	4.77 (2.39)	4.55 (2.35)	4.22 (2.28)	4.11 (2.25)	3.88 (2.20)	80.81
T_8: Fipronil 5% SC @1ml/L	8.44 (3.07)	8.00 (3.00)	7.33 (2.88)	6.77 (2.78)	6.11 (2.65)	5.66 (2.58)	4.66 (2.38)	4.33 (2.30)	4.78 (2.40)	76.36
T_9: *Lecanicillium lecanii* (1x10^8 CFU's/ml) @2ml/L	6.78 (2.79)	5.66 (2.58)	5.44 (2.53)	4.44 (2.33)	3.78 (2.18)	3.22 (2.05)	3.11 (2.02)	2.66 (1.91)	2.33 (1.81)	88.47
T_{10}: Control	9.55 (3.25)	10.44 (3.38)	12.44 (3.67)	12.88 (3.72)	12.66 (3.69)	14.33 (3.91)	15.44 (4.05)	17.88 (4.35)	20.22 (4.61)	
C.D (P ≤ 0.05)	NS	0.35	0.38	0.45	0.42	0.41	0.38	0.34	0.33	
S.E(m)	0.13	0.12	0.13	0.15	0.14	0.14	0.13	0.11	0.11	
C.V.	7.58	7.27	7.93	9.90	9.74	9.83	9.58	8.68	8.52	

DBS- Day before spray, DAS- Days after spray and figures in parentheses are square root transformations and NS- Non-significant

which was at par with T_9 (4.44 mites/flower) and T_1 (4.89 mites/flower). At 15DAS, T_5 (3.44 mites/flower), T_3 (3.66 mites/flower) and T_9 (3.78 mites/flower) were observed to be the best treatments exhibiting non-significant variation with each other followed by T_1 (4.55 mites/flower). Post second spray, at 1 DAS, T_5 was observed to be the best treatment followed by T_3 followed by T_9. At 3 and 7 DAS, the best treatment was found to be T_5 followed by T_3 followed by T_9. At 15 DAS, T_5 (1.00 mites/flower) excelled over all the treatments which was statistically at par with T_3 (1.33 mites/flower) followed by T_9 (2.33 mites/flower). Further, among the treatments, T_8 emerged out as the least efficient treatment. The per cent protection values revealed highest per cent protection provided by T_5 i.e., 91.47 and 95.05 per cent followed by T_3 i.e., 85.15 and 93.42 per cent on both leaves and flowers respectively (Fig 2). The results are in consonance with Varghese and Mathew (8) who found spiromesifen as an effective treatment for mites in chilli since it is essentially an acaricide. Further, chlorfenapyr was observed as an effective acaricide by Nagrare and Rampal (4). When the insects come in contact with the treated surface, the spores of *Lecanicillium lecanii* adheres to the insect cuticle followed by its entry via cuticle penetration. The hyphae produced from germinating spores

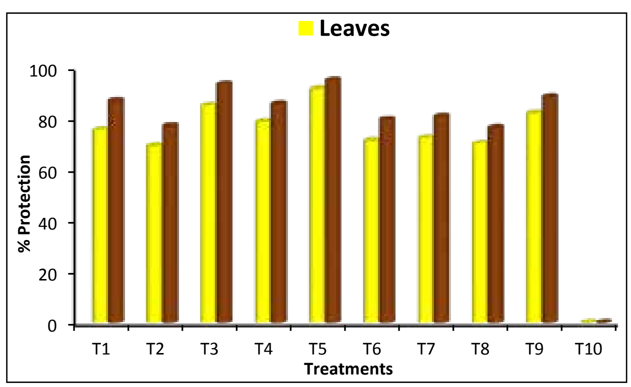


Fig. 2. Percent protection provided by different treatments against mites in leaves and flowers of gerbera (Only one legend shown. What about other i.e. flowers).

that penetrate the insect cuticle infect the mites followed by their mortality due to the destruction of internal body content. Also, azadirachtin treated surfaces act as feeding deterrents which prevent the establishment of mite colonies while spinosad being an insecticide lack the acaricidal properties thereby showing low efficacy against mites.

The study concluded that highest mite incidence under polyhouse conditions was observed during 24^{th} and 27^{th} SMW on leaves and flowers respectively. On the basis of correlation studies, mite population was found to be positively and negatively correlated with temperature and relative humidity, respectively. The regression analysis further showed a significant impact of 59 and 60 per cent variation of mite population on leaves and flowers on account of weather parameters. Spiromesifen 5% EC @ 1ml/L was found as most efficient treatment against mites.

As per the conclusions of the study, following suggestions are recommended for the suppression of mites thereby reducing the crop losses: (1) The peak mite incidence was observed during June and July. Hence, use of management strategies should be done before that to prevent the pest population from reaching the peak. (2) Use of acaricides along with entomopathogens gives good control over the mite infestation.(3) The use of natural enemies to suppress the pest population should be encouraged.

AUTHORS' CONTRIBUTION

Conceptualization of research (AM); Designing of the experiments (MJA and IZ); Contribution of experimental materials (ITN and FAK); Execution of field/lab experiments and data collection (IZ); Analysis of data and interpretation (NN, AM and IZ); Preparation of the manuscript (AM and IZ).

DECLARATION

The authors declare no conflict of interest.

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