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Prithiv Raj V
Division of Entomology, Sher-e- Kashmir University of Agricultural Sciences and Technology-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Abu Manzar
Division of Entomology, Sher-e- Kashmir University of Agricultural Sciences and Technology-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir) India

M Jamal Ahmad
Division of Entomology, Sher-e- Kashmir University of Agricultural Sciences and Technology-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Imtiyaz T Nazki
Division of Floriculture and Landscaping Architecture, Sher-e- Kashmir University of Agricultural Sciences and Technology-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Zahoor Ahmad Bhat
Division of Plant Pathology, Sher-e- Kashmir University of Agricultural Sciences and Technology-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Imran Khan
Division of Agricultural Statistics, Sher-e- Kashmir University of Agricultural Sciences and Technology- Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Mudasir Magray
Division of Vegetable Sciences, Sher-e- Kashmir University of Agricultural Sciences and Technology-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Qurat-ul-Ain
Division of Entomology, Sher-e- Kashmir University of Agricultural Sciences and Technology-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Correspondence
Abu Manzar
Sher-e- Kashmir University of Agricultural Sciences and Technology-Kashmir, Shalimar Campus, Srinagar, Jammu and Kashmir, India

Management of major sucking pests on carnation under protected conditions in Kashmir

Prithiv Raj V, Abu Manzar, M Jamal Ahmad, Imtiyaz T Nazki, Zahoor Ahmad Bhat, Imran Khan, Mudasir Magray and Qurat-ul-Ain

Abstract
Studies were conducted on management of major sucking pests *viz*., thrips, aphids and mites on carnation during the year 2017-2018 at Floricultural experimental block, SKUAST-K, Srinagar. Bio-efficacy of entomopathogen, insect growth regulator, botanical and newer molecule of insecticides against thrips (*Thrips florum*) showed Acetamiprid 20% SP + Nimbecidine 0.03% as most effective in reducing thrips population up to 86.92% and 87.66% in leaves and flowers respectively followed by Fipronil 5% SC (83.02 and 83.80).For aphids (*Rhopalosiphum maidis*) also similar treatment gave best result followed by Acephate 75% SP + Nimbecidine 0.03%.Although Propargite 57% EC proved least effective against thrips and aphids both on leaves and flowers but ranked best with respect to mites, *Tetranychus urticae* (85.92% and 81.13%) in leaves and flowers respectively. Benefit Cost Ratio (BCR) was highest in Acetamiprid 20% SP + Nimbecidine 0.03% (1:1.88).

Keywords: Acetamiprid, management, nimbecidine, propargite and sucking pests

Introduction
The awareness on the usage of cut flowers for various occasions has raised the demand for flowers in the global market increasing the area under their production. India has been identified as one of the major forces in the world floriculture scenario. With the liberalization of Indian economy, floriculture has become a new rising industry in agribusiness. Flowers are grown on an area of 2.48 lakh hectare producing 16.58 lakh tonnes of loose flowers and 4.84 lakh tonnes of cut flowers (Janakiram, 2018) [8]. Moreover, the production of cut flowers has gone upto 6,667 million stems in 2011 in comparison to 2,071 million stems in 2007 (Naqvi, 2011) [14].
Jammu and Kashmir having suitable agro-climatic conditions for variety of flowers has gained importance in floriculture sector. The floriculture industry in J&K has increased tremendously, which is evident from increase in area under flower production from 80 hectares in 1996 to 255 hectares in 2015 (Sheikh *et al*., 2015) [22]. Carnation is one such commercially grown cut flower crop in Kashmir valley having great economic value. The major problems faced by growers in the production of carnation on commercial scale are non-availability of Hi-tech production, lack of knowledge of current advances of flower production, lack of knowledge about diseases, insect-pests and their control methods (Raina *et al*., 2017). The most common pests associated with carnation are thrips [*Thrips florum* and *Thrips hawaiiensis*], spider mites (*Tetranychus urticae* Koch), aphid (*Rhopalosiphum maidis)* and bud borer (*Helicoverpa armigera*) which cause noticeable damage and loss to the growers in Kashmir valley.
In view of substantial economic loss caused by these pests to carnation, chemical control is necessary. However, repeated application of pesticides, have led to serious challenge of resistance development in pests especially thrips (Immaraju *et al*., 1992) [7], mites (Masahiro Osakabe *et al*., 2009) [12], and aphids (Silva *et al*., 2012) [23]. This necessitates to find an alternative long term, cost effective and sustainable control strategy with more emphasis on bio-intensive approaches. Since no work has been done on these aspects in carnation in Jammu & Kashmir, hence, keeping in view the economic importance of crop and the magnitude of damage caused by the major sucking pests, the present study was proposed.

Materials and Methods
Investigations were made during 2017-2018 to study the bio-efficacy of treatments against the major sucking pests' *viz*., thrips, aphids and mites in Floricultural experimental block,

SKUAST-K, Srinagar. Carnation var. "Red King" was raised with recommended agronomic practices maintaining spacing of 20 × 20 cm (row to row and plant to plant) with plot size of 1.5 x 1 m^2 of 9 plots in each bed.

The experiment comprised nine treatments including one botanical, one entomopathogen, one IGR (Insect Growth Regulator) and five new molecular pesticides along with an untreated control. The design of the experiment was RBD with each treatment replicated thrice. Details of treatment are tabulated as below (Table 1):

Table 1: Treatment details against major sucking pests on carnation under polyhouse condition

T_1	Thiamethoxam 25% WG @ 0.2 g/l followed by Nimbecidine 0.03% @ 5 ml/l
T_2	Acetamiprid 20% SP @ 0.5 g/l followed by Nimbecidine 0.03% @ 5 ml/l
T_3	Acephate 75% SP @ 0.5 g/l followed by Nimbecidine 0.03% @ 5 ml/l
T_4	Buprofezin 25% SC @ 0.8 ml/l followed by Nimbecidine 0.03% @ 5 ml/l
T_5	*Lecanicilliumlecanii*(1×10^8 CFU/ml) @ 2 ml/l followed by Nimbecidine 0.03% @ 5 ml/l
T_6	Nimbecidine 0.03% @ 5 ml/l three sprays (repeated at fortnightly interval)
T_7	Fipronil 5% SC @ 2 ml/l (Standard check)
T_8	Propargite 57% EC @ 2 ml/l (Standard check)
T_9	Control

The treatments were imposed by using a hand sprayer after taking the pre-treatment counts of thrips, aphids and mites. Subsequent second spray was given at 15 days interval. For recording observations, three plants were randomly selected from each plot and number of thrips, aphids and mites was recorded at 1 day before and 1, 3, 7, and 15 days after each spray. The data were subjected to statistical analysis.

Cost benefit ratio was worked out for different treatments. For this purpose, the cost of cultivation along with plant protection measures *viz*., cost of insecticide formulation and labour days for spray were worked out. Gross return of crop was worked out on the basis of prevailing market price. The net return per hectare was worked out for all the treatments by subtracting the cost of cultivation from the gross returns. The return per rupee invested (B: C ratio) was also calculated by dividing the net profit by total cost of cultivation.

$$\text{B:C ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation (plant protection + cost of cultivation)}}$$

Result and Discussion

Pre-treatment counts of thrips made a day prior to first spray did not exhibit significant variation among treatments (Table 2). At 1 DAS, T_2 (Acetamiprid 20% SP) recorded the lowest population of thrips (1.01 thrips/leaf) followed by T_3 (Acephate 75% SP) with 1.22 thrips/leaf and T_5 (*Lecanicillium lecanii* (1x10^8 CFU/ml) with 1.33 thrips/leaf. At 3 DAS, T_2 excelled over all other treatments with 0.44 thrips/leaf followed by T_7 (0.67 thrip/leaf) and T_3 (0.78 thrip/leaf). At 7 DAS, T_2 and T_3 were significantly superior over treatments exhibiting 0.89 and 1.22 thrips/leaf. At 15 DAS, T_2 (1.89 thrips/leaf) and T_1 (2.01 thrips/leaf) were superior over other treatments and were at par with each other followed by T_3 (2.11 thrips/leaf) and T_7 (2.33 thrips/leaf).

Similarly, on first day after second spray, T_2 (Acetamiprid 20% SP + Nimbecidine 0.03%) recorded lowest thrips population of 1.11 thrips/leaf and was significantly superior over other treatments, followed by T_7 (Fipronil 5% SC [alone]) with 1.33 thrips/leaf and T_3 (Acephate 75% SP + Nimbecidine 0.03%) with 1.67 thrips/leaf. On 3 DAS, T_2 (Acetamiprid 20% SP + Nimbecidine 0.03%) was superior over the other treatments followed by T_7, Fipronil 5% SC (0.77 thrip/leaf) and T_1, Thiamethoxam 25% WG + Nimbecidine 0.03% (0.78 thrip/leaf).Similar trend in treatment efficacy was also followed at 7 DAS.T_2 (0.77 thrip/leaf) and T_7 (1.00 thrip/leaf) were significantly superior over the other treatments on 15 DAS. T_8 (Propargite 57% EC [alone]) was the least effective among the treatments imposed (3.55 thrips/leaf).On flowers too thrips count a day prior to first spray did not did not vary significantly among treatments. At 1 DAS, T_2 (Acetamiprid 20% SP) recorded the lowest thrips population (2.89 thrips/flower). The next effective treatments were T_7, Fipronil 5% SC (3.67 thrips/flower) and T_8, Propargite 57% EC (4.33 thrips/flower).Significantly lowest thrips population was observed on the crop treated with T_2, Acetamiprid 20% SP (1.44 thrips/flower) on 3 DAS. On 7 DAS T_2, Acetamiprid 20% SP (2.01 thrips/flower) followed by T_7, Fipronil 5% SC (2.44 thrips/flower) maintained their efficacy in suppressing the thrips population. Similar trend was observed in 15 DAS. The data revealed that T_2, Acetamiprid 20% SP + Nimbecidine 0.03% was the most effective treatment on 1, 3, 7 and 15 DAS which reduced the thrips population to 1.77, 0.89, 1.22, 1.44 thrips/flower on second spray, respectively.T_7, Fipronil 5% SC and T_3, Acephate 75% SP + Nimbecidine 0.03% were also notable in their efficacy in terms of their persistence till 15 DAS recording 1.89 and 2.33 thrips/flower, respectively. Among the treatments, T_7 (Propargite 57% EC [alone]) showed considerably poor efficacy, with 7.33 thrips/flower. On the basis of per cent protection both on leaves and flowers, T_2 provided highest protection of 86.92 and 87.66 per cent against thrips. These findings are in agreement with the Reddy *et al.* (2005) [19]. Who found Acetamiprid most effective against *Scirtothrips dorsalis.* The next best treatments were T_7 (83.02 and 83.80%) and T_3 (79.28 and 80.03%).Present results also agree with Mahalingappa *et al.* (2011) [10], who found Fipronil as most effective against thrips in chilli. Gupta (2016) [4], and Rani and Reddy (2001) [8], also reported Acephate as highly effective in reducing the population of thrips on capsicum and rose. Sayeda *et al.* (2011) [21] also reported that effective control of onion thrips could be achieved by the application of Nimbecidine at flowering period. Lowest per cent protection was recorded in T_8 (39.73 and 37.19%).

Pre-treatment counts did not exhibit significant variation in aphid population, on leaves among different treatments. At 1 and 3 DAS, the lowest aphid number (1.00 and 0.66 aphid/leaf) respectively, was recorded in T_5, *Lecanicillium lecanii* (1×10^8 CFU/ml) followed by T_2, Acetamiprid 20% SP (1.11 and 0.78 aphids/leaf). On 7 DAS, lowest aphid population was observed in T_2, Acetamiprid 20% SP (1.22 aphids/leaf) followed by T_4 (Buprofezin 25% SC) with 1.45 aphids/leaf.T_2proved the best treatment at 15 DAS also (1.78 aphids/leaf) followed by T_3, Acephate 75% SP (1.88

aphids/leaf) and T_7, Fipronil 5% SC (2.01 aphids/leaf), respectively. T_8, Propargite 57% EC @ 2 ml/l and T_6, Nimbecidine 0.03% @ 5 ml/l were the least effective treatments (3.33 and 3.22 aphids/leaf) respectively. Onfirst day after second spray, least number of aphids (0.77 aphid/leaf) was observed in T_2, Acetamiprid 20% SP + Nimbecidine 0.03% followed by T_3, Acephate 75% SP + Nimbecidine 0.03% (1.11 aphids/leaf). On 3 and 7 DAS, T_2 (Acetamiprid 20% SP + Nimbecidine 0.03%) proved superior over the other treatments which recorded 0.22 and 0.44 aphid/leaf respectively, followed by T_3, Acephate 75% SP + Nimbecidine 0.03% (0.33 and 0.78 aphid/leaf). Similar trend was observed in 15 DAS. On flowers, the population density of aphids ranged 1.22 to 3.44 aphids/flower a day before spray (1 DBS). At 1 DAS, T_2 (Acetamiprid 20% SP) suppressed aphid population upto 0.67 aphids/flower. T_2, excelled over the other treatments at 3 and 7 DAS (Table 3). At 15 DAS T_1, Thiamethoxam 25% WG proved as best treatment (1.33 aphids/flower) followed by T_2, Acetamiprid 20% SP (1.44 aphids/flower) and T_4, Buprofezin 25% SC (1.78 aphids/flower). On 1st and 3 days after second spray, T_2, Acetamiprid 20% SP + Nimbecidine 0.03% (0.89 and 0.22 aphid/flower) and T_3, Acephate 75% SP + Nimbecidine 0.03% (1.01 and 0.34 aphids/flower) proved effective in supressing the aphid population as compared to other treatments and maintained their superiority even at 7 and 15 DAS. T_8, Propargite 57% EC (alone) however exhibitedleast effect (4.11 aphids/flower).Highest per cent protection of 87.89 and 89.01 against aphids was shown by T_2, Acetamiprid 20% SP + Nimbecidine 0.03% which proved as best treatment followed by T_3, Acephate 75% SP + Nimbecidine 0.03% (81.65 and 85.19%) and T_7, Fipronil 5% SC alone (77.61 and 83.36%) both on leaves and flowers in carnation. Treatment T_8, Propargite 57% EC alone (36.88 and 31.61%) showed lowest per cent protection. Present findings get support from Dattatraya and Shyamal (2007) [1] and Pritesh Patel (2015) [15], who found Acetamiprid very effective against aphids in chrysanthemum and gerbera. Gupta (2016) [4], also reported Acephate and Fipronil as most effective against aphids in capsicum. These findings are in agreement with the present observation. Vishal *et al.* (2007) [24] reported extract of neem very effective in managing aphids in chrysanthemum.

Pre-treatment count of mites on leaves made a day prior to first spray did not exhibit significant variation in population among different treatments (Table 4). At 1 and 3 DAS, the lowest population was observed in T_8, Propargite 57% EC (13.24 mites/leaf) and (7.29 mites/leaf) respectively, followed by T_5, *Lecanicillium lecanii* ($1x10^8$ CFU/ml) (12.29 mites/leaf) and T_4, Buprofezin 25% SC (13.07 mites/leaf). T_8, showed its superiority even at 7 and 15 DAS followed by T_4, Buprofezin 25% SC (10.99 and 15.11 mites/leaf) and T_7, Fipronil 5% SC (11.99 and 15.01 mites/leaf).One day after second spray, T_8 (Propargite 57% EC [alone]) was significantly superior which recorded lowest mite population (5.44 mites/leaf). The next best treatments were T_4, Buprofezin 25% SC + Nimbecidine 0.03% (7.78 mites/leaf) and T_5, *Lecanicillium lecanii* ($1x10^8$ CFU/ml) + Nimbecidine 0.03% (9.89 mites/leaf), which were at par with each other. T_8 maintained its superiority At 3, 7 and 15 DAS, showing lowest number of mites (2.89, 3.88 and 4.77 mites/leaf) followed by T_5, *Lecanicillium lecanii* ($1x10^8$ CFU/ml) + Nimbecidine 0.03% (4.33, 5.33 and 6.11 mites/leaf) and T_4, Buprofezin 25% SC + Nimbecidine 0.03% (5.11, 6.22 and 8.0 mites/leaf). T_6, Nimbecidine 0.03% (alone) was the least effective treatment (17.66 mites/leaf) on 15 DAS. On flowers, the mite population density ranged from 39.01 to 52.45 mites/flower on 1 DBS. On 1 DAS, T_8, Propargite 57% EC (36.33 mites/flower) and T_1, Thiamethoxam 25% WG (36.56 mites/flower) were superior over the other treatments. At 3 DAS, T_1, Thiamethoxam 25% WG (28.01 mites/flower) and T_8, Propargite 57% EC (30.22 mites/flower) proved effective over other treatments. T_8, again excelled over the other treatments at 7 and 15 DAS by way of reducing the mite population (25.22 and 31.33 mites/flower). T_1, Thiamethoxam 25% WG (28.44 and 31.67 mites/flower) and T_7, Fipronil 5% SC (29.89 and 34.01 mites/flower) also resulted in significant reduction of mite population till 15 DAS. One day after the second spraying, T_8 (alone) (12.33 mites/flower), followed by T_5, *Lecanicillium lecanii* ($1x10^8$ CFU/ml) + Nimbecidine 0.03% (22.66 mites/flower) and T_4, Buprofezin 25% SC + Nimbecidine 0.03% (24.44 mites/flower) were superior in recording the lowest mite population. Similar trend was observed in 3 DAS. At 7 and 15 DAS, lowest mite population was recorded in T_8 (10.66 and 11.55 mites/flower) and T_5, *Lecanicillium lecanii* ($1x10^8$ CFU/ml) + Nimbecidine 0.03% (13.33 and 15.0 mites/flower) and proved superior over the other treatments. Among the treatments evaluated, T_3 (Acephate 75% SP + Nimbecidine 0.03%) showed poor efficacy (32.66 mites/flower). T_8, Propargite 57% EC (alone) emerged as the best treatment recording highest protection of both leaves (85.92) and flowers (81.13 per cent against the carnation mitesfollowed by T_5, *Lecanicillium lecanii* ($1x10^8$ CFU/ml) + Nimbecidine 0.03% (81.97 and 75.49%) and T_4, Buprofezin 25% SC + Nimbecidine 0.03% (76.39 and 74.42%). Present observations are in absolute agreement with Herron *et al.* (2003) [6], Rai *et al.* (2011) [16], Gupta (2016) [4], and Sandeep *et al.* (2017) [20] who documented Propargite as highly effective against *Tetranychus urticae* Koch. Fielder *et al.* (2002) and Mote *et al.* (2003) [13] reported application of *Lecanicillium lecanii*as effective against *T. urticae* Koch. Kavitha *et al.* (2007) [9] and GurlazKaur (2014) [5] observed use of Buprofezin as effective in reducing the population of mites on okra and chilli.

Effect of different treatments on yield and economics of carnation

T_2, Acetamiprid 20% SP + Nimbecidine 0.03% recorded maximum yield of 234 flowers/m^2/year and highest net return of Rs. 54,68,880. The present findings get support from the findings of Dhananjaya Kumar (2007) [2], who recorded the highest number of branches/plant (i.e. more number of flowers) in Acetamiprid treated rose plots as compared to other treatments.T_3, Acephate 75% SP + Nimbecidine 0.03% (227.33 flowers/m^2/year and net return Rs. 51,43,710), T_5, *Lecanicillium lecanii* ($1x10^8$ CFU/ml) + Nimbecidine 0.03% (222.67 flowers/m^2/year and net return Rs. 49,21,820) were the other promising treatments (Table 5).These findings are in concurrence with Manju *et al.* (2016) [11] who also recorded the highest yield of carnation in *L. lecanii* treated plots. Among the treatments imposed, significantly lowest yield was recorded in T_7, Propargite 57% EC (167.67 flowers/m^2/year) and T_6, Nimbecidine 0.03% (183.33 flowers/m^2/year) treated carnation crops. Highest B: C ratio of 1.88 was recorded in T_2, Acetamiprid 20% SP + Nimbecidine 0.03% followed by T_3, Acephate 75% SP + Nimbecidine 0.03% (1.82) and T_5, *Lecanicillium lecanii* ($1x10^8$ CFU/ml) + Nimbecidine 0.03% (1.79).

Table 2: Evaluation of treatments against thrips infesting carnation (leaves and flower bud)

Treatments	LEAVES										FLOWER BUD									
	No. of thrips/leaf (I[st] Spray)					**No. of thrips/leaf (II[nd] Spray)**				**% Protection**	**No. of thrips/flower bud (I[st] Spray)**					**No. of thrips/flower bud (II[nd] Spray)**				**% Protection**
	1DBS	**1DAS**	**3DAS**	**7DAS**	**15DAS**	**1DAS**	**3DAS**	**7DAS**	**15DAS**		**1DBS**	**1DAS**	**3DAS**	**7DAS**	**15DAS**	**1DAS**	**3DAS**	**7DAS**	**15DAS**	
T_1	1.56 (1.60)	1.33 (1.53)	0.89 (1.38)	1.44 (1.57)	2.01 (1.73)	1.67 (1.63)	0.78 (1.33)	0.89 (1.37)	1.56 (1.59)	73.51	6.01 (2.62)	5.34 (2.49)	3.22 (2.03)	4.11 (2.22)	5.33 (2.49)	3.44 (2.10)	1.66 (1.63)	2.33 (1.82)	3.00 (1.99)	74.29
T_2	1.33 (1.53)	1.01 (1.41)	0.44 (1.20)	0.89 (1.38)	1.89 (1.70)	1.11 (1.45)	0.22 (1.10)	0.44 (1.19)	0.77 (1.33)	86.92	5.00 (2.44)	2.89 (1.94)	1.44 (1.54)	2.01 (1.72)	3.44 (2.10)	1.77 (1.67)	0.89 (1.37)	1.22 (1.49)	1.44 (1.56)	87.66
T_3	1.89 (1.70)	1.22 (1.49)	0.78 (1.33)	1.22 (1.49)	2.11 (1.76)	1.67 (1.63)	1.11 (1.45)	0.89 (1.37)	1.22 (1.49)	79.28	6.33 (2.67)	4.89 (2.39)	2.89 (1.94)	3.78 (2.15)	5.44 (2.51)	2.66 (1.91)	1.11 (1.45)	1.44 (1.56)	2.33 (1.82)	80.03
T_4	1.78 (1.67)	1.44 (1.57)	1.11 (1.46)	1.78 (1.67)	2.67 (1.92)	1.89 (1.69)	1.22 (1.49)	1.44 (1.56)	2.11 (1.76)	64.18	5.78 (2.56)	5.01 (2.40)	3.45 (2.07)	4.33 (2.27)	5.55 (2.53)	4.44 (2.30)	3.22 (2.02)	3.55 (2.11)	3.89 (2.19)	66.67
T_5	1.44 (1.57)	1.33 (1.53)	0.89 (1.38)	1.44 (1.57)	2.33 (1.83)	1.78 (1.67)	1.0 (1.41)	1.22 (1.49)	1.44 (1.56)	75.55	6.33 (2.69)	5.89 (2.61)	4.67 (2.37)	4.78 (2.39)	6.45 (2.71)	4.33 (2.31)	1.77 (1.67)	2.55 (1.87)	3.33 (2.07)	71.46
T_6	1.56 (1.60)	1.33 (1.53)	1.01 (1.41)	1.44 (1.57)	2.67 (1.92)	2.55 (1.88)	2.11 (1.76)	1.44 (1.56)	3.11 (2.03)	47.19	6.67 (2.77)	6.33 (2.71)	5.33 (2.52)	5.56 (2.56)	7.33 (2.89)	5.56 (2.56)	4.11 (2.55)	5.11 (2.47)	5.89 (2.62)	49.52
T_7	2.22 (1.79)	1.56 (1.60)	0.67 (1.29)	1.44 (1.57)	2.33 (1.83)	1.33 (1.52)	0.77 (1.33)	0.89 (1.37)	1.00 (1.41)	83.02	5.11 (2.47)	3.67 (2.16)	2.01 (1.72)	2.44 (1.85)	3.78 (2.18)	2.55 (1.88)	1.11 (1.45)	1.78 (1.66)	1.89 (1.69)	83.80
T_8	1.67 (1.63)	1.44 (1.57)	1.11 (1.46)	1.89 (1.70)	3.01 (2.01)	2.55 (1.88)	2.11 (1.76)	2.66 (1.91)	3.55 (2.13)	39.73	5.22 (2.48)	4.33 (2.30)	3.22 (2.04)	4.33 (2.29)	5.78 (2.60)	5.01 (2.44)	4.33 (2.29)	5.22 (2.49)	7.33 (2.88)	37.19
T_9	2.22 (1.79)	2.44 (1.85)	3.01 (2.01)	3.44 (2.11)	4.01 (2.24)	4.33 (2.31)	4.67 (2.38)	5.22 (2.49)	5.89 (2.62)	-	6.44 (2.72)	7.33 (2.87)	8.11 (3.01)	9.11 (3.17)	10.01 (3.31)	10.56 (3.39)	11.11 (3.47)	11.67 (3.55)	11.67 (3.56)	-
C.D (5%)	NS	0.17	0.16	0.15	0.17	0.19	0.17	0.18	0.14	-	NS	0.39	0.28	0.29	0.29	0.3	0.36	0.33	0.21	-

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

Table 3: Evaluation of treatments against aphids infesting carnation (leaves and flower bud)

Treatments	LEAVES										FLOWER BUD									
	No. of aphids/leaf (I[st] Spray)					**No. of aphids/leaf (II[nd] Spray)**				**% Protection**	**No. of aphids/flower bud (I[st] Spray)**					**No. of aphids/flower bud (II[nd] Spray)**				**% Protection**
	1DBS	**1DAS**	**3DAS**	**7DAS**	**15DAS**	**1DAS**	**3DAS**	**7DAS**	**15DAS**		**1DBS**	**1DAS**	**3DAS**	**7DAS**	**15DAS**	**1DAS**	**3DAS**	**7DAS**	**15DAS**	
T_1	3.33 (2.08)	2.89 (1.97)	1.89 (1.70)	2.34 (1.82)	3.11 (2.02)	1.55 (1.59)	0.89 (1.37)	1.11 (1.45)	1.44 (1.56)	73.58	2.00 (1.73)	1.22 (1.49)	0.33 (1.15)	0.67 (1.29)	1.33 (1.52)	1.01 (1.39)	0.56 (1.23)	0.67 (1.29)	1.11 (1.45)	81.53
T_2	1.89 (1.70)	1.11 (1.45)	0.78 (1.33)	1.22 (1.49)	1.78 (1.67)	0.77 (1.33)	0.22 (1.10)	0.44 (1.19)	0.66 (1.29)	87.89	1.22 (1.48)	0.67 (1.26)	0.22 (1.10)	0.56 (1.24)	1.44 (1.57)	0.89 (1.37)	0.22 (1.10)	0.40 (1.19)	0.66 (1.29)	89.01
T_3	2.33 (1.81)	1.55 (1.59)	0.89 (1.37)	1.55 (1.58)	1.88 (1.69)	1.11 (1.45)	0.33 (1.15)	0.78 (1.33)	1.00 (1.41)	81.65	2.22 (1.79)	0.78 (1.33)	0.56 (1.23)	0.78 (1.33)	1.44 (1.57)	1.01 (1.41)	0.34 (1.15)	0.56 (1.23)	0.89 (1.37)	85.19
T_4	1.89 (1.70)	1.44 (1.56)	0.99 (1.40)	1.45 (1.56)	2.22 (1.79)	1.78 (1.67)	0.89 (1.37)	1.11 (1.45)	1.55 (1.59)	71.55	2.22 (1.79)	1.45 (1.56)	0.89 (1.37)	1.22 (1.49)	1.78 (1.67)	1.22 (1.49)	0.67 (1.29)	0.78 (1.33)	1.44 (1.56)	76.04
T_5	2.11 (1.75)	1.00 (1.41)	0.66 (1.29)	1.89 (1.69)	2.55 (1.88)	2.11 (1.76)	1.56 (1.59)	1.67 (1.63)	2.00 (1.72)	63.30	3.44 (2.10)	2.22 (1.79)	2.11 (1.76)	2.56 (1.88)	3.22 (2.05)	2.56 (1.88)	1.67 (1.63)	1.78 (1.66)	2.22 (1.79)	63.06
T_6	2.67 (1.91)	1.89 (1.69)	1.45 (1.55)	2.00 (1.73)	3.22 (2.05)	1.78 (1.66)	1.22 (1.48)	1.01 (1.39)	2.66 (1.91)	51.19	2.22 (1.78)	1.89 (1.69)	1.11 (1.45)	1.22 (1.48)	1.78 (1.66)	1.22 (1.48)	0.56 (1.23)	1.20 (1.49)	2.66 (1.91)	55.74
T_7	2.33 (1.82)	1.78 (1.66)	1.11 (1.45)	1.66 (1.63)	2.01 (1.73)	1.33 (1.52)	0.77 (1.33)	1.01 (1.41)	1.22 (1.49)	77.61	3.11 (2.02)	2.67 (1.91)	1.45 (1.56)	1.78 (1.67)	2.45 (1.86)	1.78 (1.66)	0.77 (1.33)	0.90 (1.37)	1.00 (1.41)	83.36
T_8	3.01 (2.01)	2.67 (1.91)	2.33 (1.82)	2.77 (1.94)	3.33 (2.08)	2.67 (1.91)	2.22 (1.79)	2.66 (1.91)	3.44 (2.10)	36.88	1.67 (1.63)	1.33 (1.52)	1.01 (1.41)	1.56 (1.60)	2.22 (1.80)	1.67 (1.63)	1.01 (1.41)	2.20 (1.79)	4.11 (2.26)	31.61
T_9	1.33 (1.52)	1.67 (1.62)	2.11 (1.76)	3.22 (2.05)	3.77 (2.18)	3.89 (2.21)	4.34 (2.31)	4.78 (2.40)	5.45 (2.54)	-	2.11 (1.75)	2.33 (1.82)	2.89 (1.97)	3.56 (2.13)	4.45 (2.34)	4.78 (2.40)	5.01 (2.45)	5.33 (2.52)	6.01 (2.65)	-
C.D (5%)	NS	0.28	0.27	0.28	0.24	0.26	0.23	0.24	0.26	-	NS	0.39	0.33	0.31	0.26	0.26	0.25	0.21	0.19	-

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

Table 4: Evaluation of treatments against mites infesting carnation (leaves and flower bud)

Treatments	LEAVES										FLOWER BUD									
	No. of mites/leaf (I[st] Spray)					**No. of mites/leaf (II[nd] Spray)**				**% Protection**	**No. of mites/flower bud (I[st] Spray)**					**No. of mites/flower bud (II[nd] Spray)**				**% Protection**
	1DBS	**1DAS**	**3DAS**	**7DAS**	**15DAS**	**1DAS**	**3DAS**	**7DAS**	**15DAS**		**1DBS**	**1DAS**	**3DAS**	**7DAS**	**15DAS**	**1DAS**	**3DAS**	**7DAS**	**15DAS**	
T_1	18.01 (4.35)	16.35 (4.17)	13.41 (3.79)	15.66 (4.08)	17.33 (4.28)	12.33 (3.65)	6.33 (2.70)	6.89 (2.80)	8.33 (3.05)	75.42	39.01 (6.33)	36.56 (6.12)	28.01 (5.37)	28.44 (5.39)	31.67 (5.69)	24.66 (5.06)	15.00 (3.99)	16.78 (4.21)	17 (4.24)	72.23
T_2	24.33 (5.00)	23.79 (4.97)	19.85 (4.56)	20.66 (4.65)	24.01 (4.99)	18.33 (4.38)	11.78 (3.57)	13.33 (3.77)	15.44 (4.04)	54.44	50.01 (7.14)	46.44 (6.89)	40.67 (6.46)	39.33 (6.35)	43.01 (6.64)	33.22 (5.83)	27 (5.29)	28.33 (5.42)	29.44 (5.52)	51.91
T_3	17.33 (4.20)	16.79 (4.19)	13.18 (3.73)	14.88 (3.96)	16.89 (4.18)	14.44 (3.86)	11.56 (3.47)	12.33 (3.62)	14.01 (3.83)	58.66	47.22 (6.93)	43.67 (6.67)	37.78 (6.22)	38.33 (6.26)	42.45 (6.59)	36.00 (6.08)	26.89 (5.28)	30.66 (5.63)	32.66 (5.79)	46.65
T_4	24.56 (4.92)	21.57 (4.71)	13.07 (3.70)	10.99 (3.41)	15.11 (3.93)	7.78 (2.92)	5.11 (2.44)	6.22 (2.68)	8.0 (2.99)	76.39	52.45 (7.30)	49.11 (7.07)	42.33 (6.58)	43.67 (6.68)	47.78 (6.98)	24.44 (5.04)	13.77 (3.84)	14.55 (3.94)	15.66 (4.08)	74.42
T_5	19.01 (4.47)	15.46 (4.06)	12.29 (3.64)	14.10 (3.89)	17.01 (4.20)	9.89 (3.29)	4.33 (2.31)	5.33 (2.51)	6.11 (2.66)	81.97	50.33 (7.17)	44.66 (6.75)	40.22 (6.42)	40.67 (6.46)	44.78 (6.77)	22.66 (4.86)	12.66 (3.69)	13.33 (3.78)	15.00 (3.99)	75.49
T_6	30.01 (5.57)	27.46 (5.33)	23.30 (4.93)	23.77 (4.98)	29.01 (5.48)	25.67 (5.16)	20.56 (4.63)	17.44 (4.28)	17.66 (4.32)	47.89	46.33 (6.86)	38.55 (6.29)	36.22 (6.10)	36.22 (6.10)	39.33 (6.35)	36.11 (6.09)	31.11 (5.67)	30.56 (5.62)	29.55 (5.53)	51.73
T_7	24.89 (4.87)	22.79 (4.82)	15.85 (4.05)	11.99 (3.55)	15.01 (3.87)	10.22 (3.24)	6.11 (2.60)	7.56 (2.85)	9.55 (3.18)	71.82	46.01 (6.84)	39.88 (6.38)	31.33 (5.68)	29.89 (5.53)	34.01 (5.90)	25.55 (5.13)	15.22 (4.03)	17.22 (4.26)	18.44 (4.41)	69.87
T_8	16.55 (4.12)	13.24 (3.73)	7.29 (2.85)	9.33 (3.13)	11.11 (3.46)	5.44 (2.53)	2.89 (1.97)	3.88 (2.18)	4.77 (2.40)	85.92	47.11 (6.92)	36.33 (6.11)	30.22 (5.57)	25.22 (5.11)	31.33 (5.67)	12.33 (3.65)	9.77 (3.28)	10.66 (3.40)	11.55 (3.54)	81.13
T_9	18.01 (4.33)	20.79 (4.65)	22.30 (4.81)	24.33 (5.02)	26.33 (5.21)	27.45 (5.32)	29.11 (5.48)	30.78 (5.63)	33.89 (5.90)	-	46.33 (6.87)	48.89 (7.06)	49.78 (7.12)	51.34 (7.23)	54.11 (7.42)	55.78 (7.53)	57.33 (7.63)	58.78 (7.72)	61.22 (7.88)	-

C.D (5%)	NS	0.63	0.61	0.67	1.24	0.91	0.72	0.79	0.66	-	NS	0.65	0.75	0.88	0.83	0.64	0.37	0.44	0.33	-

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

Table 5: Effect of different treatments on yield of carnation (cut flower)

Treatments	No. of marketable flowers/m^2/year	No. of marketable flowers/ha/year(in Lakhs)	Total cost of cultivation (/ha)in Rs	Grossreturns (/ha)in Rs	Netreturns (/ha)in Rs	BCR
T_1	202.67	20.27	62,15,740	1,01,35,000	39,19,260	1.63
T_2	234.00	23.4	62,31,120	1,17,00,000	54,68,880	1.88
T_3	227.33	22.73	62,21,290	1,13,65,000	51,43,710	1.82
T_4	208.67	20.87	62,11,760	1,04,35,000	42,23,240	1.67
T_5	222.67	22.27	62,13,180	1,11,35,000	49,21,820	1.79
T_6	183.33	18.33	62,10,040	91,65,000	29,54,960	1.47
T_7	217.00	21.7	62,24,660	1,08,50,000	46,25,340	1.74
T_8	167.67	16.77	62,26,540	83,85,000	21,58,460	1.34
T_9	113.00	11.3	62,01,540	56,50,000	-5,51,540	0.91
C.D (5%)	19.96	-	-	-	-	-

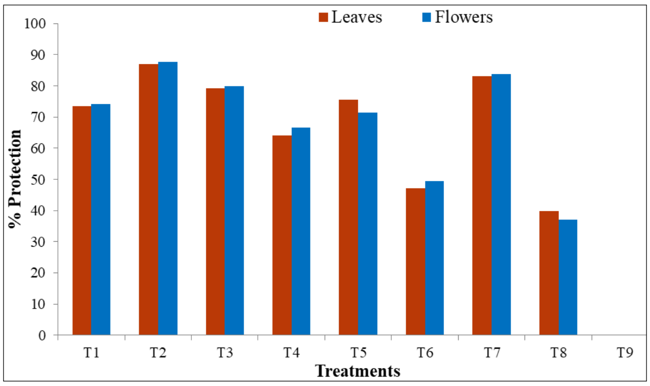

Fig 1: Effect of different treatments against thrips in leaves and flower bud on carnation

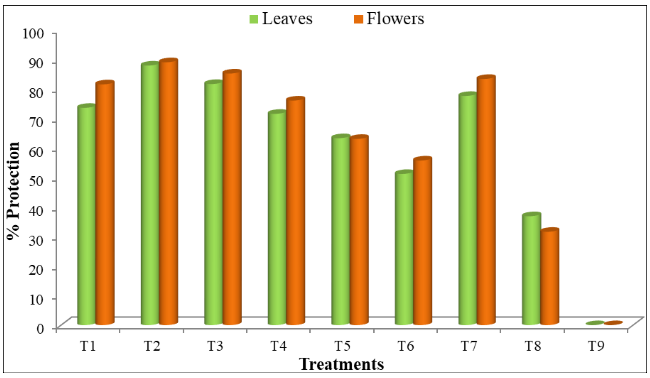

Fig 2: Effect of different treatments against aphids in leaves and flower bud on carnation

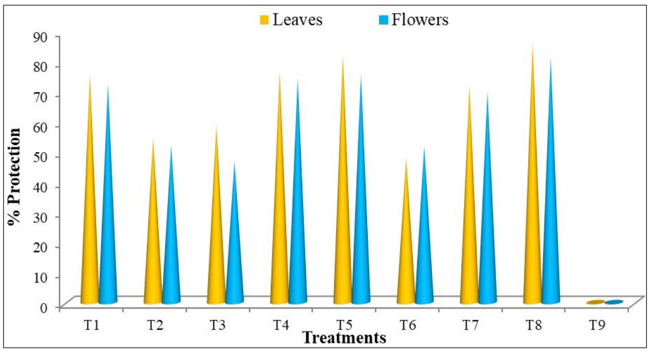

Fig 3: Effect of different treatments against mites in leaves and flower bud on carnation

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References

1. Dattatraya, Shyamal N. Insect pests associated with flower crops under south Gujarat region with special reference to bionomics and chemical control of chrysanthemum aphids. M. Sc. (Agri). Thesis; Depatrment of Agricultural Entomology, Navsari Agricultural University, 2007.
2. Dhananjaya Kumar KS. Incidence and management of mites and thrips on rose under naturally ventilated polyhouse condition. M. Sc. (Agri.).Thesis; University of Agricultural Sciences, Dharwad, Karnataka, 2007.
3. Fiedler Z, Sosnowska D, Baranowski T. The fungal pathogens and active substance of Fitoverm-abamectin in biological control against greenhouse pests. Progress in Plant Protection. 2002; 42(2):420-423.
4. Gupta JK. Seasonal incidence of insect-pest complex on capsicum (*Capsicum annum* L.) and their management under shade net house. Ph. D (Agri). Thesis; Sri Karan Narendra Agriculture University, Jobner, Rajasthan, 2016.
5. GurlazKaur. Population dynamics and management of insect pests of chilli. M. Sc. (Agri.). Thesis; Punjab Agricultural University, Ludhiana, Punjab, 2014.
6. Herron GA, Rophail J, Holloway J, Barchia I. Potentiation of a propargite and fenpyroximate mixture against two-spotted spider mite, *Tetranychus urticae* (Acari: Tetranychidae). Experimental and Applied Acarology. 2003; 29:115-119.
7. Immaraju JA, Paine TD, Bethke JA, Robb KL, Newman JP. Western flower thrips (Thysanoptera: Thripidae) resistance to insecticides in Coastal California greenhouses. Journal of Economic Entomology. 1992; 85(1):9-14.
8. Janakiram T. Doubling Farmers Income through Technological Interventions in Flower crops. Advances in Floriculture and Urban Horticulture, 2018, 3-10.
9. Kavitha J, Bhaskaran EV, Gunasekaran K, Ramaraju K. Evaluation of new Acaricides against two spotted spider mite, *Tetranychus urticae* Koch. On Bhendi. Journal of Acarology. 2007; 17(1&2):77-78.
10. Mahalingappa PB, Reddy KD, Reddy KN, Subbaratnam GV. Bio-efficacy of certain insecticides against thrips (*Scirtothrips dorsalis* Hood) and mite

(*Polyphagotarsonemus latus* Banks) infesting chillies (*Capsicum annuum* L.). The Journal of Research Angrau. 2011; 36(1):11-15.

11. Manju KP, Giraddi RS, Mantur SM. Management of thrips on carnation (*Dianthus caryophyllus* L.) by using biorationals. International Journal of Applied and Pure Science and Agriculture. 2016; 2(3):127-132.
12. Masahiro Osakabe, Ryuji Uesugi, Koichi Goka. Evolutionary aspects of acaricide-resistance development in spider mites. Psyche, 2009, 1-11.
13. Mote UN, Mahajan PR, Kadam JR. Bioefficacy of *Verticillium lecanii* (Zomn) against sucking pests of gerbera in polyhouse. Green Pesticides for Insect Management, 2003, 178-183.
14. Naqvi J. Editorial. Floriculture Today. 2011; 16(2):8.
15. Pritesh Patel. Seasonal abundance, screening of genotypes and chemical control of gerbera aphid. M. Sc. (Agri). Thesis; Navsari Agricultural University, Gujarat, 2015.
16. Rai SN, Surendra P, Janardan Singh. Efficacy of some acaricides or insecticides against *Tetranychus urticae* Koch. onbrinjal. Resistant Pest Management Newsletter. 2011; 20(1):23-25.
17. Raina V, Nain MS, Sharma R, Khajuria S, Kumbhare NV, Bakshi M. Floriculture in Jammu and Kashmir: Performance, problems and prospects. Journal of Pharmacognosy and Phytochemistry. 2017; 1:287-293.
18. Rani J, Reddy E. Efficacy of selected insecticides against thrips (*Scirtothrips dorsalis*) on rose in polyhouse. Pest management in Horticultural ecosystems. 2001; 7(1):54-58.
19. Reddy AV, Sreehari G, Kumar AK. Evaluation of certain new insecticides against chilli thrips (*Scirtothrips dorsalis*) and mites (*Polyphagotarsonemus latus*). Research on Crops. 2005; 6(3):625-626.
20. Sandeep AR, Pradeep S, Sridhara S. Management of *Tetranychus urticae* Koch (Acarina: Tetranychidae) on carnation under polyhouse condition. Journal of Global Biosciences. 2017; 6(2):4771-4775.
21. Sayeda SA, Mohamed ME. Field evaluation of some biological formulations against *Thrips tabaci* in onion. World Applied Sciences Journal. 2011; 14(1):51-58.
22. Sheikh MQ, Bhat ZA, Sidddique MAA, Singh KP, Saha TN. Present status and prospects of floriculture in Jammu and Kashmir. Indian Council of Agricultural Research-Directorate of Floricultural Research, Pune. 2015; 13:1-38.
23. Silva AX, Jander G, Samaniego H, Ramsey JS, Figueroa CC. Insecticide resistance mechanisms in the green peach aphid *Myzus persicae* (Hemiptera: Aphididae) I: A Transcriptomic survey. PLoS ONE7. 2012; (6):1-14.
24. Vishal Kumar K, Chandrashekar, Om PrakashSidhu. Synergistic action of Neem and Karanj to aphids and mites. Journal of Entomological Research. 2007; 31(2):121-124.