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Evaluation of different doses of insecticides against aphid, *Macrosiphoniella sanborni* and coccinellids in chrysanthemum crop ecosystem

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Abstract
Chrysanthemum (*Dendranthema grandiflora* Borkh), known as the "queen of the east" and cultivated for commercial purposes in all over the world. Chrysanthemums are cultivated in India for use as cut flowers, loose flowers, potted plants and garden boundary plants. The sucking insect pests are the limiting factors for higher production as well as good quality of flowers. Among the various insect pests, *Macrosiphoniella sanborni* (Gillette) (Hemiptera: Aphididae) is the main pest responsible for the damage to chrysanthemums. For the sustainable management of aphids without causing any adverse effect on crop and natural enemies study carried out with foliar application of insecticides at different doses for the two successive years 2018-19 & 2019-20. Results revealed that the among different doses of insecticides flonicamid 50 WG @ 0.019 % found most effective against *M. sanborni* followed by acephate 50% + imidacloprid 1.8 SP @ 0.064 %. There was no adverse effect of evaluated insecticides on population of coccinellids (grubs and adults). As well as this treatments also reflected maximum yield of chrysanthemum flower.

Keywords: Acephate 50% + imidacloprid 1.8 SP, chrysanthemum, flonicamid 50 WG, *Macrosiphoniella sanborni*

Introduction
In India, floriculture is becoming a significant industry. This industry has received a lot of attention because of its many benefits, including meeting people's aesthetic demands, increasing job opportunities, guaranteeing a greater rate of return for people in rural areas and permitting the generation of additional foreign currency. One of the many crops used in floriculture is the chrysanthemum (*Dendranthema grandiflora* Borkh), sometimes known as the "queen of the east" and farmed for commercial purposes. Chrysanthemums are cultivated in India for use as cut flowers, loose flowers, potted plants and garden boundary plants. In terms of the top ten cut flowers in the global flower trade, chrysanthemums are second only to roses and are particularly valued for their variety of flower sizes and shapes, vivid colour tones and extended blossom life (Brahma, 2002) [3]. It is acknowledged as one of the five economically significant flower crops in India (Janakiram *et al*., 2006) [14]. Numerous insects and diseases degrade the quality of these blooms, costing the producers money. Therefore, it is essential to understand the pests that destroy and harm these plants as well as how to resist them (Butani, 1974) [4]. From seed germination until crop harvesting, up to 7 insect pests have been identified as harmful to this crop. The aphid *Macrosiphoniella sanborni* (Gillette) (Hemiptera: Aphididae) is the main pest responsible for the damage to chrysanthemums among them. It is an East Asian holocyclic species (Heie, 1995) [15]. While Soglia *et al*., (2002) [12] found that the increase in temperature from 15 °C to 30 °C caused a significant reduction in the nymphal period of aphids from 13.5 days to 5 days, Oetting *et al*. (1977) [7] reported that aphid damage could be observed on chrysanthemum throughout the year but that it was typically more prevalent and severe during cooler months. The Chrysanthemum aphid (*M. sanborni*), according to Jaskiewicz *et al*. (2001) [6], serves as a vector for the tomato aspermy cucumovirus (TAV) and the Chrysanthemum B carlavirus (CHVB). A thorough understanding of every aspect of pest control is required given the significance of chrysanthemum and the intensity of the aphid issue.

Materials and Method
To evaluate the newer molecules of insecticides against *M. sanborni* infesting chrysanthemum, a field experiment was laid out in a randomized block design with three replication and seven

insecticides along with control at Horticulture farm, College of Horticulture, Anand Agricultural University (AAU), Anand, Gujarat, India during *rabi* 2018-19. It is in Middle Gujarat at 22.035 North Latitude and 72.055 East Longitude and Altitude of 45 m above mean sea level. Local variety of chrysanthemum has sown at spacing of 45 cm x 30 cm with following recommended package of practices except for plant protection. Application of respective insecticides was given on the appearance of aphids and second spray was made after 15 days of first spray by using the knapsack sprayer. The population of aphids was recorded before and 1, 3, 7 and 10 days after each spray. For that purpose, five plants were selected randomly from each net plot area. Number of aphid was recorded from 15 cm long terminal twig of each plant. Population of coccinellids (grubs and adults) present on each selected plant was also recorded.

Yield of chrysanthemum flowers per plot was recorded and converted in to hectare for each treatment. The data on aphids, natural enemies and flower yield were subjected to ANOVA to draw valid conclusion.

Results and Discussion

Effect of insecticides on *M. sanorni* infesting chrysanthemum

Among the all tested insecticidal treatments (Table 1), flonicamid 50 WG @ 0.019% found most effective against *M. sanborni* and recorded minimum population (8.23 aphids / twig) while, acephate 50% + imidacloprid 1.8 SP @ 0.064% (10.49 aphids / twig) was found next in order of effectiveness during the year of 2018-19. While, data of pooled over periods and sprays of 2019-20 indicate (Table 2) that the lowest population of *M. sanborni* was recorded in flonicamid 50 WG @ 0.019% (7.45 aphids / twig) treated plot and it was at par with plots treated with acephate 50% + imidacloprid 1.8 SP @ 0.064% (8.46 aphids / twig) and flonicamid 50 WG @ 0.015% (8.64 aphids / twig). Data of pooled over year (Table 3) indicate that the flonicamid 50 WG @ 0.019% found most effective against aphids and recorded minimum population (7.84 aphids / twig) while, acephate 50% + imidacloprid 1.8 SP @ 0.064% (9.48 aphids / twig) was found next in order of effectiveness.

Effect of insecticides on coccinellids in chrysanthemum

Effect of the all tested insecticide on population of coccinellids were recorded non-significant after first and second sprays in both the years (2018-19 & 2019-20). The analysis of data reveled (Table 4 to 6) that all the tested insecticide found more of less equally safer to the cocciniellids (grubs and adults).

The highest chrysanthemum flower yield (Table 7) was recorded in the treatment of flonicamid 50 WG @ 0.019% (15,432 kg/ha) followed by acephate 50% + imidacloprid 1.8 SP @ 0.064% (14,403 kg/ha), acephate 50% + imidacloprid 1.8 SP @ 0.050% (12,963 kg/ha) and flonicamid 50 WG @ 0.015% (12,860 kg/ha).

The results are in concurrence with the findings of Suthar *et al*., (2017) [13] reported that flonicamid 50 WG most effective for the control of cumin aphid and against chrysanthemum aphid by Bethke *et al*., (2004) [2]. Rouhani *et al*., (2013) [10] noted that flonicamid at 0.1 mg/ml shows maximum mortality of *Aphis punicae*. With regard to melon aphids (*Aphis gossypii*) in chrysanthemums and green peach aphids (*Myzus persicae*) in lettuce, cabbage, broccoli, bell pepper, and collards, flonicamid was quite effective reported by Anon. (2015) [1]. Imidacloprid reduced the 92.31 per cent aphid population was recorded by Saicharan *et al*., (2017) [11]. Pawar and Bharpoda, (2013) [8] observed that the flonicamid 50 WG safer to coccinellids.

Table 1: Bio-efficacy of different insecticides against *M. sanborni* infesting chrysanthemum (2018-19)

Sr. No.	Treatments	Does ml or g/10 liter of water	Number of aphid (s) / twig at indicated days after spray											Pooled over periods and sprays
			1st spray						2nd spray					
			Before Spray	1DAS	3 DAS	7 DAS	10 DAS	Pooled over periods	1 DAS	3 DAS	7 DAS	10 DAS	Pooled over periods	
1	Flonicamid 50 WG @ 0.011%	2.25	4.34 (18.83)	4.00cd (16.00)	3.77cd (14.21)	3.58a (12.81)	3.28ab (10.75)	3.66d (13.39)	3.64cde (13.24)	3.19cd (10.17)	2.88cd (8.29)	2.61cd (6.81)	3.08d (9.48)	3.37d (11.35)
2	Flonicamid 50 WG @ 0.015%	3.00	4.32 (18.66)	4.09bc (16.72	3.78cd (14.28)	3.51de (12.32)	3.20b (10.24)	3.64d (13.24)	3.61cde (13.03)	3.23cd (10.43)	2.87cd (8.23)	2.58cd (6.65)	3.07d (9.42)	3.36d (11.28)
3	Flonicamid 50 WG @ 0.019%	3.75	4.33 (18.74)	3.94d (15.52)	2.98e (8.88)	2.44f (5.95)	2.19d (4.79)	2.89f (8.35)	3.51e (12.32)	2.99d (8.94)	2.64d (6.96)	2.29e (5.24)	2.85e (8.12)	2.87f (8.23)
4	Acephate 50% + imidacloprid 1.8 SP @ 0.039%	7.50	4.47 (19.98)	4.19b (17.55)	4.09b (16.02)	3.87c (14.97)	3.52a (12.39)	3.92b (15.36)	3.74bc (13.98)	3.35c (11.22)	3.09b (9.54)	2.83bc (8.00)	3.25c (12.39)	3.59b (12.88)
5	Acephate 50% + imidacloprid 1.8 SP @ 0.050%	10.00	4.36 (19.00)	4.09bc (16.72)	3.94bc (15.52	3.68cd (13.54)	3.38ab (11.42)	3.77c (14.21)	3.71bcd (13.76)	3.25cd (10.56)	3.05bc (9.30)	2.83bc (8.00)	3.21c (10.30)	3.49c (12.18)
6	Acephate 50% + imidacloprid 1.8 SP @ 0.064%	12.50	4.38 (19.18)	4.00cd (16.00)	3.72d (13.83)	3.38e (11.42)	2.76ab (7.61)	3.47e (12.05)	3.53de (12.46)	3.09cd (9.54)	2.87cd (8.23)	2.56d (6.55)	3.01d (9.06)	3.24e (10.49)
7	Dimethoate 30 EC, 0.03%	10.00	4.36 (19.00)	4.17b (17.38)	4.06b (16.48)	3.81c (14.51)	3.49c (12.18)	3.88b (15.05)	3.87b (14.97)	3.64b (13.24)	3.22b (10.36)	3.01b (9.06)	3.43b (11.76)	3.66b (13.39)
8	Control	-	4.34 (18.83)	4.55a (20.70)	4.57a (20.88)	4.51b (20.34)	4.67a (21.80)	4.57a (20.88)	4.21a (17.72)	4.22a (17.80)	4.25a (18.06)	4.26a (18.14)	4.23a (17.89)	4.40a (19.36)
	S.Em. ± Treatment (T)		0.06	0.04	0.06	0.08	0.08	0.03	0.06	0.08	0.09	0.08	0.04	0.02
	Period (P)		-	-	-	-	-	0.23	-	-	-	-	0.02	0.01
	Spray (S)		-	-	-	-	-	-	-	-	-	-	-	0.01
	T x P		-	-	-	-	-	0.06	-	-	-	-	0.08	0.05
	T x S		-	-	-	-	-		-	-	-	-	-	0.03

	P x S	-	-	-	-	-		-	-	-	-	-	0.02
	T x P x S	-	-	-	-	-		-	-	-	-		0.07
	C.D. at 5% Treatment (T)	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
	C. V.%	2.18	1.86	2.76	4.00	4.00	3.07	2.90	4.02	5.00	5.05	4.05	3.68

Note: DAS: Days After Spray; NS: Non significant, Sig.: Significant, Figures in parentheses are retransformed values; those outside square root transformed values, Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance, Significant parameters and interactions: S, P, T x P, T x S, T x P x S

Table 2: Bio-efficacy of different insecticides against *M. sanborni* infesting chrysanthemum (2019-20)

Sr. No.	Treatments	Does ml or g/10 liter of water	Number of aphid (s) / twig at indicated days after spray											
			1st spray						2nd spray					Pooled over periods and sprays
			Before Spray	1DAS	3 DAS	7 DAS	10 DAS	Pooled over periods	1 DAS	3 DAS	7 DAS	10 DAS	Pooled over periods	
1	Flonicamid 50 WG @ 0.011%	2.25	4.11 (17.13)	3.72 (13.83)	3.58cde (12.81)	3.29abc (10.82)	2.66bc (7.07)	3.31bcd (10.95)	3.39 (11.49)	3.16b (9.98	2.77b (7.67)	2.39b (5.71)	2.93b (8..58)	3.12bc (9.73)
2	Flonicamid 50 WG @ 0.015%	3.00	3.80 (14.44)	3.36 (11.28)	3.51de (12.32)	2.86c (8.17)	2.37bc (5.61)	3.02e (9.12)	3.32 (11.02)	3.13b (9.76)	2.66b (7.07)	2.33b (5.42)	2.86b (8.17)	2.94cd (8.64)
3	Flonicamid 50 WG @ 0.019%	3.75	3.77 (14.21)	3.26 (10.62)	2.44f (5.95)	2.81c (7.89)	2.14c (4.57)	2.66f (7.07)	3.31 (10.95)	3.08b (9.48)	2.53b (6.40)	2.26b (5.10)	2.79b (7.78)	2.73d (7.45)
4	Acephate 50% + imidacloprid 1.8 SP @ 0.039%	7.50	4.31 (18.57)	4.00 (16.00)	3.87b (14.97)	3.63ab (13.17)	2.78b (7.72)	3.57b (12.74)	3.58 (12.81)	3.17b (10.04)	2.68b (7.18)	2.27b (5.15)	2.92b (8.52)	3.24b (10.49)
5	Acephate 50% + imidacloprid 1.8 SP @ 0.050%	10.00	4.49 (20.16)	3.92 (15.36)	3.68bcd (13.54)	3.63ab (13.17)	2.69bc (7.23)	3.48bc (12.10)	3.38 (11.42)	2.84b (8.06)	2.68b (7.18)	2.16b (4.66)	2.76b (7.61)	3.12bc (9.73)
6	Acephate 50% + imidacloprid 1.8 SP @ 0.064%	12.50	4.28 (16.31)	3.58 (12.81)	3.38e (11.42)	3.30abc (10.89)	2.21bc (4.88)	3.12de (9.73)	3.32 (11.02)	2.84b (8.06))	2.61b (6.81)	2.04b (4.16)	2.71b (7.34)	2.91cd (8.46)
7	Dimethoate 30 EC, 0.03%	10.00	4.52 (20.43)	3.43 (11.76)	3.81bc (14.51)	3.25bc (10.56)	2.69bc (7.23)	3.29cd (10.82)	3.27 (10.69)	3.03b (9.18)	2.69b (7.23)	2.41b (5.80)	2.85b (8.12)	3.07bc (9.42)
8	Control	-	3.92 (15.36)	3.96 (15.68)	3.85a (14.82)	4.51a (20.34)	3.71a (13.76)	4.00a (16.00)	3.96 (15.68)	4.00a (16.00)	3.92a (15.36)	3.93a (15.44)	3.96a (15.68)	3.98a (15.84)
	S.Em. ± Treatment (T)		0.21	0.19	0.08	0.17	0.17	0.08	0.24	0.22	0.21	0.21	0.11	0.07
	Period (P)		-	-	-	-	-	0.06	-	-	-	-	0.07	0.05
	Spray (S)		-	-	-	-	-		-	-	-	-	-	0.03
	T x P		-	-	-	-	-	0.17	-	-	-	-	0.22	0.14
	T x S		-	-	-	-	-		-	-	-	-	-	0.10
	P x S		-	-	-	-	-		-	-	-	-	-	0.07
	T x P x S		-	-	-	-	-		-	-	-	-	-	0.20
	C.D. at 5% Treatment (T)		NS	NS	Sig.	Sig.	Sig.	Sig.	NS	Sig.	Sig.	Sig.	Sig.	Sig.
	C. V.%		8.87	8.77	4.00	9.02	11.04	8.89	12.17	11.96	12.99	14.48	12.97	11.50

Note: DAS: Days After Spray; NS: Non significant, Sig.: Significant, Figures in parentheses are retransformed values; those outside square root transformed values, Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance, Significant parameters and interactions: S, P, T x P, T x S, T x P x S

Table 3: Bio-efficacy of different insecticides against *M. sanborni* infesting chrysanthemum (Pooled over years)

Sr. No.	Treatments	Number of aphid (s) / twig		Pooled over period, sprays and Years
		2018-19	2019-20	
1	Flonicamid 50 WG @ 0.011%	3.37d (11.35)	3.12bc (9.73)	3.24bcd (10.94)
2	Flonicamid 50 WG @ 0.015%	3.36d (11.28)	2.94cd (8.64)	3.15cd (9.92)
3	Flonicamid 50 WG @ 0.019%	2.87f (8.23)	2.73d (7.45)	2.80e (7.84)
4	Acephate 50% + imidacloprid 1.8 SP @ 0.039%	3.59b (12.88)	3.24b (10.49)	3.41b (11.62)
5	Acephate 50% + imidacloprid 1.8 SP @ 0.050%	3.49c (12.18)	3.12bc (9.73)	3.31bc (10.95)
6	Acephate 50% + imidacloprid 1.8 SP @ 0.064%	3.24e (10.49)	2.91cd (8.46)	3.08d (9.48)
7	Dimethoate 30 EC, 0.03%	3.66b (13.39)	3.07bc (9.42)	3.37b (11.35)
8	Control	4.40a (19.36)	3.98a (15.84)	4.19a (17.55)
	S.Em. ± Treatment (T)	0.02	0.07	0.06
	P	0.01	0.05	0.08

	Y	-	-	0.02
	S	0.01	0.03	0.04
	P x Y		-	0.03
	P x S	0.02	0.07	0.09
	P x T	0.07	0.14	0.07
	Y x S		-	0.02
	Y x T		-	0.05
	S x T	0.03	0.10	0.05
	P x Y x S		-	0.05
	P x Y x T		-	0.11
	P x S x T	0.07	0.20	0.11
	Y x S x T		-	0.07
	P x Y x S x T		-	0.15
	C. D. at 5% Treatment (T)	Sig.	Sig.	Sig.
	C. V. (%)	3.68	11.50	8.17

Note: DAS: Days After Spray; NS: Non significant, Sig.: Significant, Figures in parentheses are retransformed values; those outside square root transformed values, Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance, Significant parameters and interactions: P, Y, P x Y, P x T, Y x S, Y x T, S x T, P x Y x S

Table 4: Effect of different insecticides on coccinellids in chrysanthemum (2018-19)

Sr. No.	Treatments	Does ml or g/10 liter of water	Number of coccinellids/plant at indicated days after spray											
			1st spray						2nd spray					Pooled over periods and sprays
			Before Spray	1DAS	3 DAS	7 DAS	10 DAS	Pooled over periods	1 DAS	3 DAS	7 DAS	10 DAS	Pooled over periods	
1	Flonicamid 50 WG @ 0.011%	2.25	1.29 (1.16)	1.30 (1.19)	1.27 (1.11)	1.35 (1.32)	1.24 (1.04)	1.29 (1.16)	1.19 (0.92)	1.25 (1.06)	1.24 (1.04)	1.25 (1.06)	1.23 (1.01)	1.27 (1.11)
2	Flonicamid 50 WG @ 0.015%	3.00	1.37 (1.38)	1.37 (1.38)	1.27 (1.11)	1.37 (1.38)	1.30 (1.19)	1.33 (1.27)	1.27 (1.11)	1.32 (1.24)	1.22 (0.99)	1.27 (1.11)	1.28 (1.14)	1.30 (1.19)
3	Flonicamid 50 WG @ 0.019%	3.75	1.30 (1.19)	1.27 (1.11)	1.3 (1.19)	1.35 (1.32)	1.24 (1.04)	1.29 (1.16)	1.27 (1.11)	1.32 (1.24)	1.23 (1.01)	1.28 (1.14)	1.27 (1.11)	1.28 (1.14)
4	Acephate 50% + imidacloprid 1.8 SP @ 0.039%	7.50	1.18 (0.89)	1.25 (1.06)	1.27 (1.11)	1.32 (1.24)	1.22 (0.99)	1.26 (1.09)	1.19 (0.92)	1.35 (1.32)	1.27 (1.11)	1.28 (1.14)	1.27 (1.11)	1.27 (1.11)
5	Acephate 50% + imidacloprid 1.8 SP @ 0.050%	10.00	1.32 (1.24)	1.35 (1.32)	1.30 (1.19)	1.35 (1.32)	1.30 (1.19)	1.32 (1.24)	1.19 (0.92)	1.27 (1.11)	1.26 (1.09)	1.27 (1.11)	1.25 (1.06)	1.29 (1.16)
6	Acephate 50% + imidacloprid 1.8 SP @ 0.064%	12.50	1.19 (0.92)	1.3 (1.19)	1.28 (1.14)	1.32 (1.24)	1.25 (1.06)	1.30 (1.19)	1.20 (0.94)	1.30 (1.19)	1.23 (1.01)	1.30 (1.19)	1.26 (1.09)	1.27 (1.11)
7	Dimethoate 30 EC, 0.03%	10.00	1.37 (1.38)	1.32 (1.24)	1.25 (1.06)	1.35 (1.32)	1.32 (1.24)	1.31 (1.22)	1.25 (1.06)	1.32 (1.24)	1.25 (1.06)	1.25 (1.06)	1.27 (1.11)	1.29 (1.16)
8	Control	-	1.22 (0.99)	1.27 (1.11)	1.28 (1.14)	1.27 (1.11)	1.16 (0.85)	1.25 (1.06)	1.24 (1.04)	1.27 (1.11)	1.25 (1.06)	1.27 (1.11)	1.26 (1.09)	1.25 (1.06)
	S. Em. ± Treatment (T)		0.05	0.04	0.04	0.05	0.04	0.02	0.04	0.04	0.05	0.05	0.01	0..015
	Period (P)		-	-	-	-	-	0.01	-	-	-	-	0.01	0.001
	Spray (S)		-	-	-	-	-		-	-	-	-	-	0.007
	T x P		-	-	-	-	-	0.04	-	-	-	-	0.04	0.030
	T x S		-	-	-	-	-		-	-	-	-	-	0.021
	P x S		-	-	-	-	-		-	-	-	-	-	0.015
	T x P x S		-	-	-	-	-		-	-	-	-	-	0.042
	C.D. at 5% Treatment (T)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C. V.%		7.16	5.15	5.62	6.32	6.17	5.83	6.27	5.10	5.70	5.11	5.53	5.81

Note: DAS: Days After Spray; NS: Non significant, Sig.: Significant, Figures in parentheses are retransformed values; those outside square root transformed values, Significant parameters and interactions: S, P x S

Table 5: Effect of different insecticides on coccinellids in chrysanthemum (2019-20)

Sr. No.	Treatments	Does ml or g/10 liter of water	Number of coccinellids/plant at indicated days after spray											
			1st spray						2nd spray					Pooled over periods and sprays
			Before Spray	1DAS	3 DAS	7 DAS	10 DAS	Pooled over periods	1 DAS	3 DAS	7 DAS	10 DAS	Pooled over periods	
1	Flonicamid 50 WG @ 0.011%	2.25	1.10 (0.71)	1.10 (0.71)	1.15 (0.82)	1.21 (0.96)	1.27 (1.11)	1.19 (0.92)	1.22 (0.99)	1.27 (1.11)	1.30 (1.19)	1.16 (0.85)	1.24 (1.04)	1.21 (0.96)
2	Flonicamid 50 WG @ 0.015%	3.00	1.19 (0.92)	1.16 (0.85)	1.27 (1.11)	1.32 (1.24)	1.29 (1.16)	1.26 (1.09)	1.25 (1.06)	1.28 (1.14)	1.25 (1.06)	1.14 (0.8)	1.23 (1.01)	1.25 (1.06)
3	Flonicamid 50 WG	3.75	1.16	1.19	1.25	1.30	1.27	1.25 (1.06)	1.16	1.30	1.28	1.27	1.26 (1.09)	1.26 (1.09)

	@ 0.019%		(0.85)	(0.92)	(1.06)	(1.19)	(1.11)		(0.85)	(1.19)	(1.14)	(1.11)		
4	Acephate 50% + imidacloprid 1.8 SP @ 0.039%	7.50	1.38 (1.4)	1.13 (0.78)	1.13 (0.78)	1.21 (0.96)	1.22 (0.99)	1.17 (0.87)	1.19 (0.92)	1.24 (1.04)	1.21 (0.96)	1.17 (0.87)	1.20 (0.94)	1.20 (0.94)
5	Acephate 50% + imidacloprid 1.8 SP @ 0.050%	10.00	1.15 (0.82)	1.14 (0.8)	1.22 (0.99)	1.27 (1.11)	1.30 (1.19)	1.24 (1.04)	1.26 (1.09)	1.27 (1.11)	1.25 (1.06)	1.25 (1.06)	1.26 (1.09)	1.23 (1.01)
6	Acephate 50% + imidacloprid 1.8 SP @ 0.064%	12.50	1.10 (0.71)	1.11 (0.73)	1.19 (0.92)	1.19 (0.92)	1.31 (1.22)	1.20 (0.94)	1.17 (0.87)	1.32 (1.24)	1.30 (1.19)	1.22 (0.99)	1.26 (1.09)	1.22 (0.99)
7	Dimethoate 30 EC, 0.03%	10.00	1.19 (0.92)	1.11 (0.73)	1.25 (1.06)	1.32 (1.24)	1.27 (1.11)	1.24 (1.04)	1.24 (1.04)	1.25 (1.06)	1.26 (1.09)	1.16 (0.85)	1.23 (1.01)	1.24 (1.04)
8	Control	-	1.14 (0.8)	1.13 (0.78)	1.19 (0.92)	1.27 (1.11)	1.30 (1.19)	1.22 (0.99)	1.20 (0.94)	1.30 (1.19)	1.31 (1.22)	1.19 (0.92)	1.25 (1.06)	1.23 (1.01)
	S. Em. ± Treatment (T)		0.06	0.04	0.05	0.05	0.06	0.02	0.04	0.05	0.05	0.04	0.02	0..017
	Period (P)		-	-	-	-	-	0.01	-	-	-	-	0.01	0.001
	Spray (S)		-	-	-	-	-		-	-	-	-	-	0.008
	T x P		-	-	-	-	-	0.05	-	-	-	-	0.04	0.034
	T x S		-	-	-	-	-		-	-	-	-	-	0.024
	P x S		-	-	-	-	-		-	-	-	-	-	0.017
	T x P x S		-	-	-	-	-		-	-	-	-	-	0.049
	C.D. at 5% Treatment (T)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C. V.%		9.13	6.39	7.65	7.46	6.39	8.89	6.20	7.35	6.36	5.95	6.51	6.89

Note: DAS: Days After Spray; NS: Non significant, Sig.: Significant, Figures in parentheses are retransformed values; those outside square root transformed values, Significant parameters and interactions: S, P x S

Table 6: Effect of different insecticides on coccinellids in chrysanthemum (Pooled over years)

Sr. No.	Treatments	Number of coccinellids/plant		Pooled over period, sprays and Years
		2018-19	2019-20	
1	Flonicamid 50 WG @ 0.011%	1.27 (1.11)	1.21 (0.96)	1.24 (1.04)
2	Flonicamid 50 WG @ 0.015%	1.3 (1.19)	1.25 (1.06)	1.27 (1.11)
3	Flonicamid 50 WG @ 0.019%	1.28 (1.14)	1.26 (1.09)	1.28 (1.14)
4	Acephate 50% + imidacloprid 1.8 SP @ 0.039%	1.27 (1.11)	1.20 (0.94)	1.23 (1.01)
5	Acephate 50% + imidacloprid 1.8 SP @ 0.050%	1.29 (1.16)	1.23 (1.01)	1.26 (1.09)
6	Acephate 50% + imidacloprid 1.8 SP @ 0.064%	1.27 (1.11)	1.22 (0.99)	1.25 (1.06)
7	Dimethoate 30 EC, 0.03%	1.29 (1.16)	1.24 (1.04)	1.26 (1.09)
8	Control	1.25 (1.06)	1.23 (1.01)	1.24 (1.04)
	S.Em. ± Treatnent (T)	0.015	0.017	0.012
	P	0.001	0.001	0.016
	Y	-	-	0.006
	S	0.007	0.008	0.017
	P x Y		-	0.012
	P x S	0.015	0.017	0.038
	P x T	0.030	0.034	0.023
	Y x S		-	0.008
	Y x T		-	0.016
	S x T	0.021	0.024	0.016
	P x Y x S		-	0.016
	P x Y x T		-	0.033
	P x S x T	0.042	0.049	0.033
	Y x S x T		-	0.023
	P x Y x S x T		-	0.046
	C. D. at 5% Treatment (T)	NS	NS	NS
	C. V. (%)	5.81	6.84	6.35

Note: DAS: Days After Spray; NS: Non significant, Sig.: Significant, Figures in parentheses are retransformed values; those outside square root transformed values, Significant parameters and interactions: Y, P x Y and P x Y x S

Table 7: Effect of insecticides on yield of chrysanthemum flower (Pooled)

Sr. No.	Treatments	g a.i./ ha	ml or g/10 liter of water	Yield (Kg/ha)		
				2018-19	2019-20	Pooled over years
1	Flonicamid 50 WG, 0.011%	55	2.25	13,580b	11,523b	12,551b
2	Flonicamid 50 WG, 0.015%	75	3.00	13,992b	11,728b	12,860ab
3	Flonicamid 50 WG, 0.019%	95	3.75	16,461a	14,403a	15,432a
4	Acephate 50% + imidacloprid 1.8 SP, 0.039%	195	7.50	13,169b	11,728b	12,449b
5	Acephate 50% + imidacloprid 1.8 SP, 0.050%	259	10.00	13,992b	11,934b	12,963ab
6	Acephate 50% + imidacloprid 1.8 SP, 0.064%	320	12.50	16,049b	12,757b	14,403ab
7	Dimethoate 30 EC, 0.03%	150	10.00	13,169b	11,934b	12,552b
8	Control	-	-	8,230c	7,819c	8,024c
	S.Em. ± Treatment (T)		-	1460	966	805
	Year (Y)		-	-	-	438
	T x Y		-	-	-	1238
	C.D. at 5% Treatment (T)		-	4429	2929	2314
	Year (Y)		-	-	-	1214
	T x Y		-	-	-	NS
	C.V.%		-	18.60	14.26	16.94

Note: Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance

Conclusion

The research has shown that the treatment of flonicamid 50 WG @ 0.019% found most effective while, acephate 50% + imidacloprid 1.8 SP @ 0.064% and flonicamid 50 WG @ 0.015% were found next in order of their effectiveness against *M. sanborni* infesting chrysanthemum. As well as this treatments also reflected maximum yield of chrysanthemum flower. There was no adverse effect of evaluated insecticides on population of coccinellids (grubs and adults).

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