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Comparative evaluation of pesticides and biorationals against key pests of greenhouse chrysanthemum

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ABSTRACT

Chrysanthemum (*Dendranthema grandiflora*) is grown for year round flower production in greenhouses. Greenhouse experiments were conducted in Centre for Protected Cultivation Technology (CPCT), IARI, New Delhi for two seasons during 2009 - 2010 to study the efficacy of individual and integrated treatments for the management of key insect pests of chrysanthemum. Results revealed that in all the tested insecticides, the integrated treatments were most effective in comparison to the individual interventions. Combined treatment of phosphamidon and cypermethrin was the most effective for the key pests, *viz*. aphid and caterpillar. Efficacy of caterpillar management by spinosad increased after three days of application (94.44%) in comparison to first two days (13.20 and 30.33%, respectively) of application and it persisted up to 10 days of application which was not observed in controlling aphid. In chrysanthemum aphid control, the effectiveness of the treatment of agricultural spray oil and azadirachtin was decreased immediately after two 2 days of spraying, whereas combined treatment of both showed very effective result. Agricultural spray oil and azadirachtin are more acceptable than conventional insecticides as they are known to be active against pest populations but are relatively more environment-friendly to beneficial organisms.

Key words: Chrysanthemum, greenhouse, agricultural spray oil, azadirachtin, *Macrosiphoniella*, *Spodoptera*, pesticides.

INTRODUCTION

Chrysanthemum (*Dendranthema grandiflora* Borkh), has been recognized as one among the five commercially important potential flower crops in India (Janakiram *et al*., 7). However, under greenhouse its quality and production is adversely affected by insect pests such as aphid, caterpillars, mites, whiteflies, thrips and leaf miner. Among these pests, chrysanthemum aphid and spodopteran caterpillars were found to be the key pests in experimental greenhouses. Chrysanthemum aphid (*Macrosiphoniella sanborni*) is an important pest of chrysanthemum that causes direct damage through feeding resulting in wilting, leaf distortion, and transmission of several viruses; and indirect damage through physical contamination with aphid exuviae and honeydew which is a nutrient source of sooty mold (Agrios, 3). All of these factors together cause significant economic damage to chrysanthemum crops mainly flowers, by decreasing their beauty and marketability. Chrysanthemum caterpillar (*Spodoptera litura*) is another pest causing enormous losses. The use of good agricultural practices and integrated pest management (IPM) are being increasingly advocated in protected cultivation (Sabir *et al*., 14). Biorational pesticides such as agricultural spray oils and azadirachtin have shown to be effective against the most common polyhouse pests (Smith and Krischik, 15). Among the plants possessing environment-friendly compounds, azadirachtin is proving to be a valuable asset on account of its insecticidal properties (Abdullah, 2). It has been considered as an environmentally and toxicologically reduced risk material and has been embraced by IPM practitioners as a biorational pesticide (Williams *et al.*, 17), which offers a new tool for insect resistance management (Thompson and Sparks, 16). Use of potentiating mixture is a useful strategy to combat insecticide resistance. There are some results, which strongly support the use of insecticides with different mode of action in mixtures in order to avoid the resistance development (Archer *et al.*, 5; McKenzie and Byford, 9; Yamamoto *et al.*, 18). The synergistic interactions may occur between the different components used in combination, leading to increased efficacy (Sayyad *et al.*, 11). The present work is an attempt to evaluate the efficacy of insecticides, individually and or in combination for the management of aphids and caterpillars in chrysanthemum under greenhouse conditions.

MATERIALS AND METHODS

The experiments were conducted in the green house of Centre for Protected Cultivation Technology

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(CPCT), IARI, New Delhi for two crop seasons, *i.e.* 2009 and 2010. Chrysanthemum cv. Garland was grown following the recommended package of practices. The experiment was laid out in a randomized block design with 16 treatments replicated three times including control. Each replication comprised of a raised bed of size 3 × 1 m^2 with 25 cm height.

All the 16 treatments (except control T-16) involve the application of five pesticides (shown in Table 1) individually or in combination (Tables 2 & 3). Two sprays were performed, at an interval of 15 days, 1 week after natural appearance of the aphid and *Spodoptera* on the crop. All the inputs like manure, irrigation and cultural practices were uniformly applied to all the treatments. For observations, three plants were randomly selected from each plot and tagged. Aphid population was recorded from three leaves (top, middle, and bottom) randomly in each of the tagged plant and average population was recorded. For recording data of caterpillar population, whole plants were considered. The observations were recorded before the spray as well as 1, 2, 3, 7 and 10 days after each spray. The data for insect incidence and different insect populations were pooled for both the years. Results were expressed as percent mortality with correction for untreated (control) mortality using Abbott's formula (Abbott, 1), transformed to arcsine for homogenizing the variances. The data were subjected to ANOVA.

RESULTS AND DISCUSSION

The data on efficacy of insecticides applied alone and in combination for the control of chrysanthemum aphids and caterpillars are presented in Tables 2 and 3, respectively. The results on the evaluation of insecticides against *Spodoptera* indicated that all the insecticides/biorationals applied individually or in combination indicated higher larval mortality (6.73 to 98.33%) as compared to control (Table 2). Among all the combinations the treatment T5 (Spinosad after 7 days of application) and T13 (phosphamidon and cypermethrin) proved most effective. It is interesting to note that in Treatments T-6, T-7, T-8, T-10 and T-11, synergistic interaction was observed between insecticides and agricultural spray oil or azadirachtin. The existence of synergistic interactions between pyrethroids and organophosphates has been reported in different insects such as lepidopterans (Martin *et al.*, 8). In the field, spinosad activity is characterized by cessation of feeding and paralysis of exposed insects within minutes. However, these insects may remain on the plant for up to two days (Richards and Christian, 13). In the present experiment, low mortality of *Spodoptera* larvae due to spinosad for the first two days might be due to presence of the insects in the plant although they ceased feeding. After 2^{nd} day there was sharp increase in the mortality. Mendez *et al.*, (10) have also reported the effective control of lepidopteran larvae with the treatment of spinosad.

Evaluation of insecticides against aphids indicated that all the insecticides applied individually or in combination, in general, indicated higher aphid mortality as compared to control (Table 3). Among different treatments, the highest mortality (81.87%) was observed in treatments T-3 (phosphamidon), T-8 (Agricultural spray oil + cypermethrin) and T-10 (azadirachtin + phosphamidon) after 3^{rd} day of application. Mixing of two chemical insecticides (T-13, T-14 and T-15) did not result in much increase in their efficacy as a final product infact a decline in it was observed up to 3^{rd} day in T-13, however after 7^{th} and 10 days there was an increase in the mortality. Spinosad was significantly less effective against aphid as compared to phosphamidon and cypermethrin. Application of spinosad with other insecticide T-14 and T-15 has negative effect and had resulted significant reduction in the activity of those chemicals with which it has been applied. It is evident from the present study that the mixing of two chemical insecticides has not yielded in any synergistic effect, instead may lead to the development of insecticidal resistance. Therefore, such mixtures of two pesticides, a general practice among farmers should be discouraged. Interestingly, mixing of cypermethrin and phosphamidon with agricultural spray oil or azadirachtin in most of the cases has got synergistic effect. Spraying of

Table 1. Details of the insecticides used in the experiment.

Treatment	Source	Conc. (%)	Percent active ingradient in the product
Agricultural spray oil (Agrospray®)	Indian Oil Corporation Ltd.	0.50	-
Azadirachtin (Neem Baan®)	Pest Control (India) Pvt. Ltd.	0.02	1500 ppm (0.15%)
Phosphamidon (Dimecron®)	Novartis India Ltd.	0.50	85 SL
Cypermethrin (Barricade®)	Kenvos Chemical Co. Ltd.	0.50	10 EC
Spinosad (Conserve®)	Dow Agrosciences	0.02	SC (11.6%)

Table 2. Effect of insecticides on the mortality of chrysanthemum caterpillars in greenhouse.

Treatment		Conc. (%)	Per cent mortality of caterpillar population after treatment*				
			1 day	2 day	3 day	7 day	10 day
T1	Agricultural spray oil	0.50	18.66^{ghij} (25.55)	21.33^{hij} (27.49)	34.00^{fg} (35.67)	25.22^{fgh} (30.13)	18.66^{fg} (25.55)
T2	Azadirachtin	0.02	6.73^{ij} (15.00)	17.33^{j} (24.58)	11.33^{ij} (19.64)	14.66^{hi} (22.46)	13.25^{ghi} (21.30)
T3	Phosphamidon	0.50	32.33^{fg} (34.63)	36.86^{def} (37.35)	51.73^{de} (45.97)	69.00^{b} ((56.17)	53.83^{cd} (47.18)
T4	Cypermethrin	0.50	33.00^{f} (35.06)	36.20^{defg} (36.99)	43.64^{ef} (41.32)	47.13^{c} (43.28)	36.06^{e} (36.87)
T5	Spinosad	0.02	13.20^{ij} (21.30)	30.33^{fghi} (30.40)	94.44^{ab} (76.31)	100.00^{a} (90.00)	94.73^{a} (76.69)
T6	Agricultural spray oil + Azadirachtin	0.50 + 0.02	29.66^{fgh} (32.96)	24.33^{fghij} (29.53)	33.83^{fg} (35.55)	33.00^{cdefg} (35.06)	15.66^{gh} (23.26)
T7	Agricultural spray oil + Phosphamidon	0.50 + 0.50	83.86^{ab} (66.27)	32.00^{fgh} (34.45)	66.73^{c} (54.82)	96.66^{a} (79.37)	90.10^{a} (84.56)
T8	Agricultural spray oil + Cypermethrin	0.50 + 0.50	65.66^{d} (54.09)	63.11^{bc} (52.59)	57.66^{cd} (49.37)	34.53^{cdef} (35.97)	28.33^{ef} (32.14)
T9	Agricultural spray oil + Spinosad	0.50 + 0.02	20.00^{ghi} (26.56)	24.00^{ghij} (29.33)	25.60^{gh} (30.40)	12.00^{hi} (20.27)	2.66^{i} (9.28)
T10	Azadirachtin + Phosphamidon	0.02 + 0.50	82.00^{abc} (64.90)	74.33^{b} (59.54)	85.46^{b} (67.54)	95.00^{a} (77.08)	66.40^{b} (54.57)
T11	Azadirachtin + cypermethrin	0.02 + 0.50	82.60^{abc} (65.35)	56.00^{cd} (48.45)	56.44^{cd} (48.68)	45.80^{cd} (42.59)	33.83^{e} (35.55)
T12	Azadirachtin + Spinosad	0.02 + 0.02	19.86^{ghi} (26.42)	29.30^{fghij} (32.77)	17.33^{hi} (24.58)	12.33^{hi} (20.53)	8.10^{ghi} (16.54)
T13	Phosphamidon + Cypermethrin	0.50 + 0.50	98.33^{a} (82.51)	99.80^{a} (87.44)	100.00^{a} (90.00)	96.66^{a} (79.37)	52.96^{cd} (46.66)
T14	Phosphamidon + Spinosad	0.50 + 0.02	56.66^{def} (48.79)	46.33^{de} (42.88)	46.00^{de} (42.71)	78.00^{b} (62.03)	55.57^{bc} (48.16)
T15	Cypermethrin + Spinosad	0.50 + 0.02	57.00^{de} (49.02)	45.66^{de} (42.48)	56.93^{cd} (48.97)	43.00^{cde} (40.98)	34.94^{e} (36.21)
T16	Control	–	3.00^{j} (9.98)	2.00^{k} (8.13)	2.66^{j} (9.28)	3.66^{i} (10.94)	1.66^{i} (7.27)
	$CD_{0.05}$		16.33	12.85	11.81	16.04	12.06

*Data based on mean of two sprays and three replicates each
Figures in parentheses are Arc Sine transformed values
In a column, 'means' followed by a common letter do not differ significantly at P ≤ 0.05 by Duncan`s Multiple Range test.

agricultural spray oil, azadirachtin and combination of both against two-spotted spider mite on cucumber were found effective under greenhouse and laboratory conditions, in which the combined treatment of both was the most effective (Deka *et al.*, 6). The petroleum oil spray residues reduced infestation of some insects by preventing oviposition and its effects depended on concentration of oil and time of spraying (Amiri Besheli, 4). Petroleum oil alone or combined with a microbial agent as emulsifier have a

Table 3. Effect of insecticides on the mortality of chrysanthemum aphids in greenhouse.

Treatment		Conc. (%)	Per cent mortality of caterpillar population after treatment*				
			1 day	2 day	3 day	7 day	10 day
T1	Agricultural spray oil	0.50	25.66^{e} (30.40)	15.66^{ij} (23.26)	14.00^{g} (21.97)	8.66^{g} (16.95)	2.00^{h} (8.13)
T2	Azadirachtin	0.50	20.10^{f} (26.64)	16.60^{ij} (24.04)	15.00^{g} (22.79)	15.65^{f} (23.26)	11.50^{fg} (19.82)
T3	Phosphamidon	0.02	70.33^{c} (56.98)	72.33^{e} (58.24)	98.00^{a} (81.87)	56.33^{d} (48.62)	38.33^{c} (38.23)
T4	Cypermethrin	0.02	48.66^{d} (44.20)	57.00^{f} (49.02)	67.33^{d} (55.12)	26.66^{e} (31.05)	13.33^{ef} (21.39)
T5	Spinosad	0.02	24.00^{e} (29.33)	17.00^{ij} (24.35)	26.66^{ef} (31.05)	10.00^{g} (18.44)	5.00^{gh} (12.92)
T6	Agricultural spray oil + Azadirachtin	0.50 + 0.50	49.33^{d} (44.60)	57.00^{f} (49.02)	67.33^{d} (55.12)	56.33^{d} (48.62)	25.00^{d} (30.0)
T7	Agricultural spray oil + Phosphamidon	0.50 + 0.02	83.00^{a} (65.65)	85.33^{bcd} (67.45)	96.33^{ab} (78.91)	77.33^{b} (61.55)	42.00^{c} (40.40)
T8	Agricultural spray oil + Cypermethrin	0.50 + 0.02	69.33^{c} (56.35)	86.00^{bc} (68.03)	98.00^{a} (81.87)	82.50^{a} (65-27)	54.00^{b} (47.27)
T9	Agricultural spray oil + Spinosad	0.50 + 0.02	19.00^{f} (25.84)	29.00^{h} (32.58)	30.33^{ef} (33.40)	9.70^{g} (18.15)	6.50^{fgh} (14.77)
T10	Azadirachtin + Phosphamidon	0.50 + 0.02	80.00^{b} (63.44)	86.33^{b} (68.28)	98.00^{a} (81.87)	71.00^{c} (57.42)	25.00^{d} (30.0)
T11	Azadirachtin + Cypermethrin	0.50 + 0.02	48.66^{d} (44.20)	72.33^{e} (58.24)	79.66^{c} (63.15)	71.00^{c} (57.42)	38.33^{c} (38.23)
T12	Azadirachtin + Spinosad	0.50 + 0.02	21.60^{f} (27.69)	16.50^{ij} (23.89)	14.60^{g} (22.46)	12.65^{fg} (20.79)	10.20^{fg} (18.68)
T13	Phosphamidon + Cypermethrin	0.02 + 0.02	88.33^{a} (70.00)	95.66^{a} (77.89)	97.66^{ab} (81.09)	83.00^{a} (65.65)	64.66^{a} (53.49)
T14	Phosphamidon + Spinosad	0.50 + 0.02	24.50^{e} (29.67)	21.00^{i} (27.28)	31.33^{e} (34.02)	26.66^{e} (31.05)	20.40^{de} (26.85)
T15	Cypermethrin + Spinosad	0.02 + 0.02	49.33^{d} (44.60)	40.00^{e} (39.23)	68.00^{d} (55.55)	23.33^{e} (28.79)	11.33^{fg} (19.64)
T16	Control		3.00^{g} (9.98)	3.00^{k} (9.98)	4.00^{h} (11.54)	2.00^{h} (8.13)	4.33^{gh} (11.97)
	CD		6.30	6.45	6.44	4.84	7.39

*Mean of three replicates.

Figures in parentheses are Arc Sine transformed values

In a column, 'means' followed by a common letter do not differ significantly at $P \leq 0.05$ by Duncan`s Multiple Range test.

synergistic and less harmful effect for the environment and are recommended for use in IPM programmes (Khyami and Ateyyat, 12). Moreover, the oil does not increase pesticide resistance because their mode of action is mechanical, not chemical. They are more acceptable than conventional insecticides as they are known to be active against pest populations but relatively innocuous to beneficial organisms. However, agricultural spray oil and azadirachtin (T6) appeared to be antagonistic when used with spinosad. Because spinosad is a mixture of two most active naturally occurring metabolites produce by soil actinomycetes, *Saccharopolyspora spinosa* that has high actively towards Lepidoptera.

The potentiating mixtures are supposed to counteract a mechanism of metabolic detoxification only over time; insects can develop resistance to even mixtures insecticides and hence should be regularly monitored.

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