

## Sustainable management of aphid in coriander (*Coriandrum sativum* L.) through botanicals and bio-pesticides

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### Abstract

In a replicated field trials, some botanical products of anti-pest plants including *Citrullus colocynthis* Linn., *Capparis decidua* (Forsk.), *Pongamia pinnata* Vent., *Annona squamosa* Linn., *Ricinus communis*, *Allium sativum* L., *Datura stramonium*, *Withania somnifera* and *Parthenium hysterophorus* L. along with two bio-products were evaluated for testing their bio-efficacy against aphids (*Hyadaphis coriandri* Das, *Myzus persicae* (Sulz.) and *Aphis craccivora* Koch) mixed population on coriander (*Coriandrum sativum* Linn.). The maximum reduction in aphid population was recorded in the plots treated with organic salt (bio-product) 5ml l<sup>-1</sup> (67.83 and 70.10%) followed by karel extract 10ml l<sup>-1</sup> (67.00 and 68.96%) and tumba fruit extract 10ml l<sup>-1</sup> (64.89 and 68.32%) in both the years, respectively. The plant formulations of custard apple leaf extract 10ml l<sup>-1</sup>, parthenium extract 10ml l<sup>-1</sup> and castor leaf extract 10ml l<sup>-1</sup>, were exhibited lower effective in reduction of aphid population on coriander. No phytotoxic symptoms were discerned on the plants over the cropping period as well as completely safe to natural enemies.

**Key words:** Bio-efficacy, botanicals & bio-products, aphids, *Coriandrum sativum* L.

### Introduction

Coriander (*Coriandrum sativum* L.) commonly known as 'Dhania' belongs to family *Apiaceae*, is an important seed spice crop grown mainly in Rajasthan, Madhya Pradesh, Andhra Pradesh and many other states of India in large to small areas. It occupied first position in production (527390 tons) while second step in area (547421 hectare) after cumin amongst all seed spices in the country during 2012-13 (Lal *et al.*, 2015). A number of insect pests, viz., thrips, jassid, *Empoasca kerri* (Pruthi), aphids, *Myzus persicae* (Araujo, 1986), *Hyadaphis coriandri* Das (Jain and Yadav, 1988), *Aphis gossypii* Glover, *Aphis craccivora* Koch, pod borer, *Heliothis armigera* (Hub.), whitefly, *Bemisia tabaci* (Genn.), seed wasp, *Systole albipennis* (Walker) (Singh and Baswana, 1984) bugs, termite and few lepidopteran caterpillar inflict damage to this crop (Anonymous, 2008 and Meena, 2005). Among them, three aphid species i.e. *Hyadaphis coriandri*, *Myzus persicae* and *Aphis craccivora* (Hemiptera: Aphididae) have been reported as a major pest on the crop.

This insect feeds in colonies on the tender portion

of the shoots, lower portion of leaves, entire umbels and in case of severe infestation, whole plant covered with young and adult aphids. Consequently, plants became weakened and growth stunted which reduced seed yield and quality. The aphids may also be acts as a vector of viral diseases like yellowing in coriander as well as cowpea mosaic and papaya mosaic on many other crops. If plant protection measures not applied on time, it causes nearly 40-50% yield losses. In present situation of agriculture, farmers are using a number of pesticides for pests control resulted in development of pest resistance to various commonly used insecticides, pest resurgence, and outbreaks as well as severe mortality of natural enemies and pollinators particularly honeybees. In addition, pesticide residue becoming a major issue particularly in cumin and coriander by which country gets a big loss in national economy. Therefore, the present work was carried to find out an alternative of chemical pesticides as new molecule of wild botanicals or bio-pesticides for the management of aphids without causing any adverse effect on crop, natural enemies, pollinators and environment.

## Materials and methods

The field experiments were carried out for two consecutive years during *Rabi* season of 2013-14 and 2014-15 at Farm, ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan (74° 35' 39" E and 26° 22' 31" N) to test the bio-efficacy of some wild botanicals as well as bio-products against aphid's (*Hyadaphis coriandri*, *Myzus persicae* and *Aphis craccivora*) mixed population on coriander (*Coriandrum sativum* Linn.). The experiments were laid out in randomized block design with three replications. The seeds of coriander's variety ACr-1 were sown in well prepared field and all recommended practices (as per POP) were adapted to the crop for luxurious growth and development. Twelve treatments (including control) i.e. *Citrullus colocynthis* (tumba fruit extract), *Capparis decidua* (karel extract), *Pongamia pinnata* (karanj leaf extract), *Annona squamosa* (custard apple leaf extract), *Ricinus communis* (caster leaf extract), *Allium sativum* (garlic extract), *Datura stramonium* (datura leaf extract), *Withania somnifera* (Ashwagandha leaf extract), *Parthenium hysterophorus* (parthenium leaf extract) along with two bio-products (organic salt and cow urine) were applied when sufficient aphid population appeared on the plants.

The above botanicals are locally available in the vicinity were collected in appropriate quantities and brought into the laboratory. Plant sap of collected material was extracted with juice extracting machine by adding water as needed and then filtered through muslin cloth and stored in capped bottles under room temperature. The spray solutions of these botanicals were prepared by dissolving recommended doses of extracts in one litre of water and also added sticker @ 1ml l<sup>-1</sup> of water for spraying on the crop. Two sprays of above treatments were given during evening hours with high volume knapsack sprayer (spray fluid 450 l ha<sup>-1</sup>) at 10 days interval.

The data on aphid population were recorded from five randomly selected and tagged plants per plot. Initially whole plant were taken into account for observations but in later stages, 15 twigs of 10 cm length of five tagged plants, i.e. one each from top,

middle, and lower portion were taken in to account. Pre treatment data were recorded one day before application of treatments and the post treatment data were recorded after one, three, seven and ten days of each spray applications. The reduction percentage of aphid population was calculated by using Abott (1925) formula:

$$P = \frac{T - C}{100 - C} \times 100$$

Where,

P = Corrected per cent mortality

T = Observed per cent mortality in treatment

C = Percent mortality in control.

The data on corrected mortality so obtained were converted into arc sin values and tabulated to statistically analyze. Per cent plant damage and seed yield of coriander (q ha<sup>-1</sup>) were also recorded from the selected plants as burning symptoms such as lesions on leaves, dryness of plants and other similar reactions as categorized by Kavadia and Gupta (1986).

## Results and discussion

The population of aphids 10cm<sup>-1</sup> long twig (average of 15 twigs) was recorded from all the treatments one day before spray application showed non-significant difference among most of the treatments, viewing homogenous distribution of aphids in the experimental plots wherein the population of aphids was varied from 5.60 to 12.06 and 12.00-14.33 aphids 10 cm<sup>-1</sup> long twigs in 2013-14 and 2014-15, respectively (Table 1 & 2).

In first year, the post treatment record on percent reduction in aphid population on *Coriandrum sativum* was taken on first day of spray application revealed that all the treatments were found significantly superior over untreated control in both the sprays. The trends of per cent mortality of aphid population were in increasing order till seventh days of treatments and then declined gradually, whereas in control plots, the aphid infestation enhanced significantly and no mortality in aphid population was recorded in both the spray applications. In first spray application, at seventh days of treatment, the maximum percent reduction

**Table 1.** Bio-efficacy of manually prepared wild botanicals and bio-products against aphid infesting coriander during 2013-14

Treatment	Dose/ Conc.	PTP Twig <sup>1</sup> (Mean of 15 twigs)	Per cent reduction in aphid population after first spray					Per cent reduction in aphid population after second spray					Mean
			10					10					
			1 DAS	3 DAS	7 DAS	DAS	Mean	1 DAS	3 DAS	7 DAS	DAS	Mean	
Tumba fruit extract	10ml L <sup>-1</sup>	10.33 (18.75)	44.50 (41.84)	48.00 (43.85)	53.75 (47.15)	53.00 (46.72)	49.81 (44.89)	55.10 (47.93)	61.00 (51.35)	64.89 (53.66)	62.71 (52.36)	60.93 (51.31)	
Dhatura leaf extract	5ml L <sup>-1</sup>	11.13 (19.45)	38.52 (38.36)	43.00 (40.98)	44.08 (41.60)	40.39 (39.46)	41.50 (40.11)	40.58 (39.57)	47.09 (43.33)	49.56 (44.75)	49.00 (44.43)	46.56 (43.03)	
Parthenium extract	10ml L <sup>-1</sup>	5.60 (13.69)	38.00 (38.06)	42.03 (40.41)	43.10 (41.03)	42.10 (40.45)	41.31 (40.00)	41.33 (40.01)	44.06 (41.59)	50.85 (45.49)	51.54 (45.88)	46.95 (43.25)	
Caster leaf extract	10ml L <sup>-1</sup>	7.73 (16.13)	36.11 (36.94)	40.05 (39.26)	43.77 (41.42)	43.01 (40.98)	40.74 (39.66)	40.00 (39.23)	42.19 (40.51)	48.10 (43.91)	48.10 (43.91)	44.60 (41.90)	
Karel extract	10ml L <sup>-1</sup>	8.00 (16.43)	49.12 (44.50)	51.28 (45.73)	54.03 (47.31)	50.43 (45.25)	51.22 (45.70)	55.93 (48.41)	60.04 (50.79)	67.00 (54.94)	67.00 (54.94)	62.49 (52.23)	
Ashwaganda leaf extract	5ml L <sup>-1</sup>	11.80 (20.17)	36.86 (37.38)	42.79 (40.85)	46.88 (43.21)	45.12 (42.20)	42.91 (40.92)	44.39 (41.78)	48.69 (44.25)	50.00 (45.00)	50.00 (45.00)	48.27 (44.01)	
Organic salt	5ml L <sup>-1</sup>	12.06 (20.29)	48.71 (44.26)	50.55 (45.32)	56.38 (48.67)	53.92 (47.25)	52.39 (46.37)	56.70 (48.85)	62.50 (52.24)	67.83 (55.45)	65.72 (54.16)	63.19 (52.65)	
Custard apple leaf extract	10ml L <sup>-1</sup>	6.73 (15.09)	37.12 (37.54)	38.49 (38.35)	40.50 (39.52)	41.23 (39.95)	39.34 (38.85)	38.51 (38.36)	40.26 (39.38)	43.72 (41.39)	40.26 (39.38)	40.69 (39.63)	
Garlic extract	5ml L <sup>-1</sup>	9.33 (17.80)	40.18 (39.34)	46.95 (43.25)	49.61 (44.78)	50.00 (45.00)	46.69 (43.10)	48.59 (44.19)	53.08 (46.77)	54.00 (47.29)	55.10 (47.93)	52.69 (46.54)	
Karanj leaf extract	10ml L <sup>-1</sup>	10.53 (18.94)	41.19 (39.93)	42.00 (40.40)	47.55 (43.60)	46.60 (43.05)	44.34 (41.75)	49.00 (44.43)	52.71 (46.55)	53.16 (46.81)	47.02 (43.29)	50.47 (45.27)	
Cow urine	50%	8.06 (16.47)	40.07 (39.27)	41.84 (40.30)	48.10 (43.91)	45.79 (42.58)	43.95 (41.53)	48.55 (44.17)	50.67 (45.38)	52.79 (46.60)	46.90 (43.22)	49.73 (44.85)	
Control	-	9.13 (17.56)	-	-	-	-	-	-	-	-	-	-	
Mean		9.21 (17.67)	40.94 (39.78)	44.27 (41.71)	47.98 (43.84)	46.51 (43.00)	44.93 (42.09)	47.15 (43.37)	51.12 (45.64)	54.72 (47.71)	53.03 (46.74)	51.52 (45.86)	
SEM±		0.89	0.48	0.77	0.75	0.70	0.70	0.70	0.68	0.69	0.74		
CD (p=0.05)		2.57	1.38	2.26	2.22	2.04	2.02	1.96	2.03	2.12			

# Average of three replications; Figure in parenthesis are arc sign transformed value; PTP-Pre-treatment population, DAS-Days after spray

**Table 2.** Bio-efficacy of manually prepared wild botanicals and bio-products against aphid infesting coriander during 2014-15

Treatment	Dose/ Conc.	PTP Twig <sup>-1</sup> (Mean of 15 twigs)	Per cent reduction in aphid population after first spray				Per cent reduction in aphid population after second spray				Mean
			7 DAS		10 DAS		7 DAS		10 DAS		
			1 DAS	3 DAS	1 DAS	3 DAS	1 DAS	3 DAS	1 DAS	3 DAS	
Tumba extract	10ml L <sup>-1</sup>	14.26 (22.18)	45.00 (42.13)	53.10 (46.78)	57.00 (49.03)	48.06 (43.89)	50.79 (45.45)	54.82 (47.77)	60.55 (51.10)	68.32 (55.75)	65.78 (52.19)
Dhatura leaf extract	5ml L <sup>-1</sup>	13.33 (21.40)	32.63 (34.83)	40.55 (39.55)	42.98 (40.96)	34.52 (35.98)	37.67 (37.84)	42.21 (40.52)	43.01 (40.98)	47.57 (43.61)	46.11 (42.77)
Parthenium extract	10ml L <sup>-1</sup>	14.00 (21.97)	40.35 (39.43)	37.02 (37.47)	43.00 (40.98)	34.21 (35.78)	38.65 (38.35)	38.72 (38.48)	43.00 (40.96)	48.33 (44.04)	45.26 (42.28)
Caster leaf extract	10ml L <sup>-1</sup>	13.20 (21.29)	32.37 (34.67)	36.54 (37.19)	39.10 (38.70)	30.13 (33.26)	34.54 (35.94)	38.96 (38.62)	42.33 (40.58)	46.05 (42.73)	36.83 (37.36)
Ker extract	10ml L <sup>-1</sup>	14.00 (21.97)	44.61 (41.90)	52.55 (46.46)	57.66 (49.41)	49.35 (44.63)	51.04 (45.60)	59.71 (50.60)	59.27 (50.35)	68.96 (56.15)	66.12 (54.41)
Ashwaganda leaf extract	5ml L <sup>-1</sup>	12.67 (20.86)	34.56 (36.01)	37.45 (37.73)	38.59 (38.39)	33.16 (35.16)	35.94 (36.81)	35.00 (36.27)	39.73 (39.07)	46.35 (42.91)	46.00 (42.70)
Organic salt	5ml L <sup>-1</sup>	13.00 (21.13)	46.30 (42.88)	58.22 (49.73)	61.03 (51.37)	48.12 (43.92)	53.42 (47.02)	62.04 (51.97)	65.35 (53.94)	70.10 (56.86)	67.67 (55.36)
Custard apple leaf extract	10ml L <sup>-1</sup>	14.20 (22.16)	30.34 (33.42)	38.10 (38.11)	38.12 (38.12)	33.05 (35.09)	34.90 (36.20)	35.69 (36.68)	38.25 (38.20)	44.60 (41.90)	43.21 (41.10)
Garlic extract	5ml L <sup>-1</sup>	12.00 (20.24)	33.96 (35.64)	45.67 (42.51)	47.73 (43.70)	34.10 (35.73)	40.37 (39.36)	41.05 (39.84)	51.01 (45.58)	54.26 (47.44)	51.35 (45.77)
Karanj leaf extract	10ml L <sup>-1</sup>	13.73 (21.77)	30.78 (33.69)	36.37 (37.09)	41.23 (39.95)	30.63 (33.60)	34.75 (36.05)	38.34 (38.26)	46.21 (42.83)	49.65 (44.80)	46.92 (43.23)
Cow urine	50%	14.33 (22.24)	34.15 (35.76)	36.00 (36.87)	40.07 (39.26)	37.14 (37.55)	36.84 (37.37)	41.27 (39.97)	47.05 (43.31)	50.37 (45.21)	46.18 (42.81)
Control	-	13.93 (21.92)	-	-	-	-	-	-	-	-	-
Mean		21.59 (27.69)	34.20 (35.79)	37.46 (37.74)	39.15 (38.74)	34.55 (36.00)	36.33 (37.07)	38.25 (38.20)	40.58 (39.57)	43.45 (41.24)	41.83 (40.30)
SEM±		0.34	0.53	0.70	0.88	0.85	0.63	0.63	0.97	0.63	0.55
CD (p=0.05)		1.00	1.55	2.06	2.60	2.49	1.86	1.84	2.83	1.84	1.62

# Average of three replications; Figure in parenthesis are arc sign transformed value; PTP-Pre-treatment population, DAS-Days after spray

(56.38%) in aphid population was recorded on the plants treated with organic salt followed by karel extract and tumba fruit extract reduced 54.03 and 53.75 per cent population, respectively and these treatments were statistically at par with each other. Garlic extract, cow urine, karanj leaf extract and ashwagandha leaf extract were next effective treatments reduced 49.61, 48.10, 47.55 and 46.88 per cent aphid population, respectively and these four treatments were also at par with each other in their effectiveness. The treatments, parthenium leaf extract and castor leaf extract were categorized as lower effective treatments reduced 43.10 and 43.77 per cent aphid population, respectively and both treatments were being on par to their efficacy. Custard apple leaf extract, was found least effective treatment against this pest reduced 40.50 per cent population which was significantly inferior to rest of the treatments (Table 1). The similar trend was observed in second spray application, where in maximum reduction 67.83 per cent was recorded in organic salt followed by karel extract and tumba fruit extract reduced 67.00 and 64.89 per cent population, respectively. The treatments organic salt and karel extract were statistically at par with each other in their efficacy. Whereas, the minimum reduction (43.72%) in aphid population was recorded in custard apple leaf extract treated plants followed by castor leaf extract and datura leaf extract. The remaining treatments were categorized as middle order of effectiveness for the control of aphid on coriander.

In second year, all the treatments were found significantly superior over untreated check during entire days after application (Table 2). Organic salt was noticed as most effective treatment against aphid on *C. sativum* which reduced 61.03 per cent population followed by karel extract and tumba fruit extract reduced 57.66 and 57.00 per cent population and these treatments were statistically at par with each other at seventh days of first spray application. The next effective treatments were garlic extract, karanj leaf extract and cow urine reduced 47.73, 41.23 and 40.07 per cent population, respectively. The minimum reduction (38.12%) in aphid population was recorded on the

plants treated with custard apple leaf extract followed by ashwagandha leaf extract and castor leaf extract reduced 38.59 and 39.10 per cent population. In second spray application, the maximum mortality 70.10 per cent was recorded in the treatment of organic salt followed by karel extract (68.96%) and tumba fruit extract (68.32% reduction), these three treatments were statistically at par with each other. No work was done on effectiveness of these botanicals against aphid especially on coriander (*C. sativum*) so far, hence the results couldn't compare and discussed. However, the similar results acquired by Torkey et al., (2009) on other crop, i.e. *Citrullus colocynthis* has good insecticidal property against *Aphis craccivora* get support the present findings. In another study was carried out by Mamun and Ahmed (2011) in Bangladesh, showed that some plant extract i.e. lantana extract, custard apple leaf extract, datura extract were found effective in management of sucking pests and mites in tea gardens, also support the present findings. The next effective treatments were garlic extract, cow urine and karanj leaf extract, reduced 54.26, 50.37 and 49.65 per cent aphid population, respectively, whereas the minimum reduction (44.60%) was recorded on the plants treated custard apple leaf extract. Meena et al., (2014) reported the effectiveness of some botanical products (garlic extract, cow urine and datura leaf extract) against *Macrosiphum luteum* on *Dendrobium nobile* also support the present study.

In over the season, the average per cent mortality in aphid population was ranged from 37.67 to 57.79 and 40.02 to 59.86 per cent in the year 2013-14 and 2014-15, respectively (Fig. 1). All the treatments were recorded significantly superior over untreated control in reduction of aphid population over the season in both the years. The maximum average per cent reduction (57.79 and 59.86 %) in aphid population was recorded in organic salt followed by karel extract (56.86 and 57.28%). The minimum mean per cent reduction was recorded in custard apple leaf extract (37.67 and 40.02%) over the season in both years.

**Effect of botanicals and bio-products on plant damage and yield of coriander**

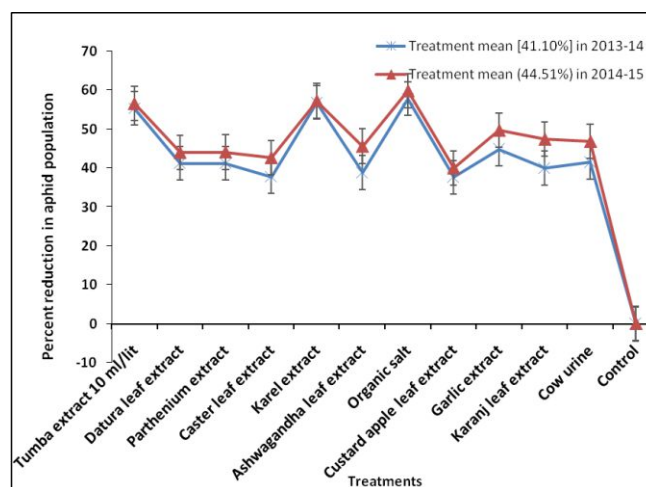
The overall average percentage of plant damage in coriander was minimum (26.33%) in the plot treated with organic salt (5ml lit<sup>-1</sup>) followed by karel extract and tumba fruit extract showed significant difference over rest of the treatments (Table 3). The highest plant damage (72.65%) recorded in untreated check which was significantly higher to all treatments.

The result of field experiments indicated that a significant difference in increase of seed yield in coriander was noticed in treated plots as compared with untreated check. The maximum yield of 13.10 q ha<sup>-1</sup> (pooled) was obtained in the plots treated with organic salt followed by karel extract and tumba fruit extract i.e. 12.33 and 11.76 q ha<sup>-1</sup> (Table 3), respectively. The minimum seed yield (8.04 q ha<sup>-1</sup>) was obtained in the plots considered as untreated check which was significantly lowest to all treatments in both the years.

**Toxicity to plants and natural enemies**

The foliar applications of these nine botanicals and

two bio-products under applied doses and concentration did not produced any phytotoxic symptoms on leaves, tender shoots and even developing seeds (Table 3). Similarly, there was no adverse effect (mortality) recorded on the populations of different natural enemies on the crop.



**Fig. 1.** Effect of botanicals and bio-products on aphids infesting coriander during 2013-14 and 2014-15 (over the season)

**Table 3.** Effect of botanicals and bio-products on percent plant damage and yield of coriander (*Coriandrum sativum* L.)

Treatments	Dose/ Conc.	Percent plant Damage (Pooled)	Intensity of Phytotoxicity (Pooled)	Seed Yield (q ha <sup>-1</sup> ) (Pooled)
Tumba extract	10ml L <sup>-1</sup>	27.80	No phytotoxic	11.76
Dhatura leaf extract	5ml L <sup>-1</sup>	47.00	No phytotoxic	10.33
Parthenium extract	10ml L <sup>-1</sup>	47.66	No phytotoxic	10.04
Caster leaf extract	10ml L <sup>-1</sup>	47.34	No phytotoxic	10.46
Ker extract	10ml L <sup>-1</sup>	27.00	No phytotoxic	12.30
Ashwaganda leaf extract	5ml L <sup>-1</sup>	48.30	No phytotoxic	10.10
Organic salt	5ml L <sup>-1</sup>	26.33	No phytotoxic	13.10
Custard apple leaf extract	10ml L <sup>-1</sup>	56.47	No phytotoxic	9.80
Garlic extract	5ml L <sup>-1</sup>	35.50	No phytotoxic	10.66
Karanj leaf extract	10ml L <sup>-1</sup>	48.10	No phytotoxic	10.46
Cow urine	50%	37.00	No phytotoxic	10.31
Control	-	72.65	No phytotoxic	8.04
Sem±		1.82	-	0.47
CD (P=0.05%)		5.33		1.37

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Received : September 2015; Revised : November 2015;  
Accepted : December 2015.