Influence of certain plant products on the insect pollinators of coriander

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ABSTRACT

Investigations were carried out to evaluate the "*Influence of certain plant products on the insect pollinators of coriander*" at Rajasthan College of Agriculture, Udaipur, during *rabi* 2008-09. The treatments comprised: *Pongamia glabra* Vent (seed oil – 1 %), *Azadirachta indica* A. Juss (seed kernel extract - 5%), formulated *neem* product (*Achook* - 0.8%), *Azadirachta indica* (seed oil - 1%), *Azadirachta indica* (leaf extract - 10%) replicated 4 times. Reduction in pollinator population was estimated one day after application of the botanicals; whereas, 3 and 5 days after the treatment the mean percentage increase or decrease in the pollinator abundance over control was computed. The plant origin insecticides evinced a decrease in pollinator intensity ranging from (-) 14.52 to (-) 25.06 per cent. The maximum reduction of insect pollinators (25.06%) was recorded from plots treated with *neem* seed oil (1%). Three days after the treatment the percentage of visiting insect pollinators did not change in plots treated with *karanj* oil (1%), but the pollinator percentage increased in plots treated with NSKE (5%) and *neem* leaf extract (10%). Most of the botanical treatments did not have any side-effect 5 days after the treatment; however, plots treated with seed oil (1%) of *Azadirachta indica* A. Juss continued to show a deterrent effect and the pollinator intensity decreased by 21.57 per cent.

Key words: Insect pollinators, coriander, crop pest, plant oils, *Pongamia glabra*, *Azadirachta indica*

INTRODUCTION

The role of pollinators in cross pollination of important agro-horticultural crops is well recognized. Insect pollination results in a uniform crop and also improves the quality of fruit. The important insect pollinators include honey bees, solitary bees (*Xylocopa, Andrena, Halictus*), bumble bees (*Bombus*), stingless bees (*Trigona, Melipona*) and many kinds of flies (*Syrphus, Bombilius*), beetles, black ants, thrips and moths. Among insects, the members of the super-family *Apoidea* (Hymenoptera) are the most important pollinators. Of the 95 per cent cross pollinated flowers, 85 per cent depend on insect pollination (Carruth, 1950); bees are responsible for almost 80 per cent of pollination and their role in enhancing crop yields is well recognized (Teale, 1957). Coriander produces a considerable quantity of nectar and thereby attracts many different insects for pollination; an external effect which is of both ecological and economic value hence is also a good melliferous plant (Luk'janov and Reznikov, 1976) with the ability of obtaining 500 kg of honey from one hectare of coriander. However, the coriander aphids are active sap suckers at bloom and later, causing considerable loss to the crop. Use of pesticides, including botanicals to manage the coriander aphid at times becomes necessary. Plant products, especially extracts/ formulations of *neem* (*Azadirachta indica* A. Juss), are often perceived as harmless to natural enemies, pollinators and other non-target organisms. For this reason, several integrated pest management (IPM) programmes have adopted *neem* as one of the prime components. Pesticide use and habitat loss often lead to pollinator decline resulting in reduced crop yields; however, Richards (2001) opined that there was no clear example of low crop yield resulting from the effect of pesticides or transgenic plants on pollinators, and only one example involving herbicides, although each of these agents can affect populations of crop pollinators. Therefore, the present investigation on, influence of certain plant products on the insect pollinators of coriander was carried out.

MATERIALS AND METHODS

The present investigation was conducted at the Horticulture farm of Rajasthan College of Agriculture, Udaipur (Rajasthan) during the *rabi* season of 2008-09. The site is situated in the south eastern part of Rajasthan at an altitude of 579.5 meter above mean sea-level, at $24^0$35'N latitude and 74^o42'E longitude. The region falls under agro-climatic zone IVa (sub-humid plain and Aravali hills of Rajasthan). A replicated trial was conducted to evaluate the effect of five botanicals on the population of

insect pollinators of coriander. Coriander variety "RCr-41" was sown in plots of 3m x 2m (6 sq. m.); before being sown the seeds were crushed into halves by gently rubbing between palms and treated with Thiram and Bavistin at the ratio of 1:1 @ 2 g/kg seed. Sowing was done by manually operated hand driven plough keeping the row to row distance of 30 cm with a seed rate of 10 kg/ha. Five irrigations were applied at an interval of 20 – 25 days and the first irrigation was applied just after sowing. Thinning was done 30 days after sowing keeping the plant to plant distance at 10 cm. Weeding was done twice after the first and second irrigation subsequently. Other recommended agronomical practices were followed as and when needed.

The six treatments comprised: *Pongamia glabra* Vent seed oil (*karanj* oil - 1%), *Azadirachta indica* A. Juss (*neem* seed kernel extract - 5%), formulated *neem* product, *Achook* (0.8%), *Azadirachta indica* (*neem* oil - 1%), *Azadirachta indica* (*neem* leaf extract - 10%). Each treatment was replicated 4 times. These botanicals were sprayed only once at 65 days after germination when the aphid population was significant to cause damage. Since the study was to record the side-effects on insect pollinators, the pollinator population was recorded one day before and 1, 3, and 5 days after treatment. Using the methodology adopted by Henderson and Tilton (1955) reduction in pollinator population was estimated one day after application of the botanicals; whereas, 3 and 5 days after the treatment the mean percentage increase or decrease in pollinator abundance over control was computed. The data thus obtained were subjected to statistical analysis wherever necessary. In case of the plant oils and kernel extract, a little quantity of teepol was mixed so that the oil could be mixed with water.

The diversity of insect pollinators of coriander was recorded from 5 plants per plot, selected at random and tagged for observing the pollinators at three different periods of the day like morning (8-10 a.m.), afternoon (12-2 p.m.) and evening (4-6 p.m.). The duration of each observation to record the pollinators was one minute per tagged plant. While taking observations, the total number of insects that visited during each observational period was noted; besides, the hymenopterans and dipterans were categorized.

Preparation of *Azadirachta* leaf and seed kernel extracts

Fresh leaves from the *neem* tree were collected and shade-dried. The dried leaves were ground to powder in an electric grinder. Known quantity (600g) of the dried leaf powder was soaked in one-third quantity of water for 12 hours. Frequent stirring was done. The extract was filtered through a muslin cloth and mixed with the remaining quantity of water. This extract was considered to be of 100 per cent concentration, later, the desired concentration (10%) for the spray was prepared after dilution with distilled water. For seed kernel extract, the mature kernels of *neem* were collected and dried in a shady place. The kernels were crushed with the help of a pastel and mortar (brass make). The powder obtained was passed through 60-mesh sieve and then mixed with luke-warm distilled water on a weight by weight basis taking equal quantities of powder and water. The suspension obtained was considered to be of 100 per cent concentration from which the desired concentration of 5 per cent was prepared by dilution using distilled water.

RESULTS

The insect pollinators that were observed to visit coriander crop included hymenopterans, dipterans, a few Lepidoptera, Hemiptera and Coleoptera; and based on the significant numbers in which they were recorded, they could be considered as the major insect pollinators. Among these, the mean total hymenopterans visiting the umbels of coriander during the entire flowering period from 28/12/2008 to 15/2/2009 happened to be 18.89/plant/minute-observation/day. Among hymenopterans, *A. florea* and *A. dorsata* were the most dominant forming 91.54 per cent. The foraging activity of *A. florea* was more pronounced during 12-2 p.m. (1.312 bees/ day/ plant/ minute observation), whereas the foraging activity of *A. dorsata* was maximum during 8-10 a.m. (0.032 bees/ day/ plant/ minute observation). While *A. florea* formed 38.86 (8-10 a.m.), 86.36 (12-2 p.m.) and 27.43 (4-6 p.m.) per cent of the total insect pollinators, the corresponding figures for *A. dorsata* were 9.35, 1.18, and 2.26 per cent for morning, afternoon and evening, respectively (Table 1).

The effect of botanicals on the intensity of insect pollinators of coriander, one day after (Table 2), showed that the mean number of insect pollinators visiting

Table 1. Diversity of insect pollinators visiting coriander and their intensity at different hours of the day

Insect Groups	Hymenopterans			Dipterans			Other orders		
Foraging Period	*Apis florea*	*Apis dorsata*	Others	Muscidae	Syrphidae	Others	Lepidoptera	Hemiptera	Coleoptera
Morning	0.133(38.86)	0.032(9.35)	0.024(7.01)	0.088(25.72)	0.0023(0.67)	0.035(10.23)	0.0011(0.32)	0.0257(7.51)	0.0011(0.32)
Afternoon	1.312(86.36)	0.018(1.18)	0.073(4.81)	0.078(5.13)	0.00057(0.0375)	0.000(Zero)	0.0022(0.14)	0.0302(1.98)	0.0051(0.34)
Evening	0.097(27.43)	0.008(2.26)	0.051(14.42)	0.0944(26.70)	0.00057(0.16)	0.061(17.25)	0.0034(0.96)	0.0354(10.01)	0.0028(0.79)

*** Figures in parentheses are corresponding per cent values**

Table 2. Effect of botanicals on the intensity of insect pollinators of coriander (Numbers /5 plants)

Treatments	Mean insect-pollinator Intensity			
	Pre-treatment	Post-treatment		
		I day	III day	V day
Karanj oil (1%)	13.00	10.00	12.25	14.5
Neem seed kernels extract(5%)	14.25	10.25	13.50	14.25
Achook (0.8%)	13.25	10.25	10.75	13.00
Neem oil (1%)	10.75	9.50	11.00	10.00
Neem leaves extract (10%)	13.00	10.75	13.50	13.25
Control	13.50	12.75	12.25	12.75

coriander were less in comparison to pre-treatment population in all the treatments with botanicals. Three days after the treatment with botanicals, the mean numbers of insect pollinators were less in *Pongamia* oil (1%), *Azadirachta* kernel extract (5%) and Achook (0.8%), but in *Azadirachta* seed oil (1%) and *Azadirachta* leaf extract (10%) there was a slight increase in the number of insect pollinators. Five days after treatment, mean numbers of insect pollinators were more in comparison to pre-treatment population of pollinators in all the treatments except *Azadirachta* seed oil (1%) and the commercial product Achook (0.8%).

When a comparison was made with regard to the pollinator population in control (Table 3), one day after treatment of coriander crop with the botanicals against the aphids, the side-effect of the plant origin pesticides showed a decrease in pollinator intensity ranging from 14.52 to -25.06 per cent and the maximum reduction of insect pollinators (25.06%) was in plots treated with *Azadirachta* seed oil (1%), However, the insect pollinator intensity reduction was not significant among the treatments. Three days after treatment the visiting insect pollinators, expressed as a percentage, did not change in plots treated with *Pongamia* seed oil (1%), though they increased in plots treated with *Azadirachta* kernel extract (5%) and *Azadirachta* leaf extract (10%), while they decreased in plots treated with Achook (0.8%) and *Azadirachta* seed oil (1%). Five days after the treatment, the percentage of insect pollinator intensity increased ranging from 1.96 to 13.73 except for that in plots treated with *Azadirachta* seed oil (1%) in which it decreased by 21.57 per cent.

Table 3. Effect of botanicals on the mean insect pollinator intensity over control

Treatments	Pollinator Intensity (%)		
	I day	III day	V day
Karanj oil (1%)	(-)21.16(27.39)	0	(+) 13.73
Neem seed kernels extract (5%)	(-)17.82(24.97)	(+)10.20	(+) 11.76
Achook (0.8%)	(-)18.38(25.39)	(-)12.25	(+) 1.96
Neem oil (1%)	(-)25.06(30.04)	(-)10.20	(-) 21.57
Neem leaves extract (10%)	(-)14.52(22.41)	(+)10.20	(+) 3.92
S. Em. ±	3.726	N.A.	N.A.
C. D.	NS		

***** Figures in parenthesis are arc sine values, + indicates per cent increase in pollinator intensity and - indicates per cent decrease in pollinator intensity

DISCUSSION

Hymenopterans and dipterans formed the major pollinators with the two species of *Apis* (*A. florea* and *A. dorsata*) among the hymenopterans, while flies of the families Muscidae and Syrphidae dominating. Similar studies on coriander could not become available from the literature; however, Mahy *et al*. (1998) recorded the dominance of insects of Hymenoptera, Diptera and Lepidoptera in the pollination system of *Calluna vulgaris*, among which honeybees and bumble bees were the most efficient pollinators while syrphid flies were important co-pollinators. Kapila *et al*. (2002) recorded bees (69.29%) as a dominant group of insect pollinators on radish, followed by Dipterans and other insects collectively. Kuberappa *et al*. (2007) recorded 10 species of insect pollinators on *Vishnu tulsi* (*O. sanctum*) belonging to order Hymenoptera and Diptera. The mean abundance of *A. florea* (8.82/plant/ 5mintues) was higher compared to *A. dorsata* (8.52/plant/ 5 minutes) and *A. cerana* (6.85/plant/5minutes). The earlier work done clearly depicts the dominance of hymeno pterans and dipterans as pollinators and more so of honeybees.

While evaluating the side-effects of plant origin pesticides it could be noted that there was a decrease in pollinator intensity ranging from 14.52 to 25.06 per cent. The maximum reduction of insect pollinators (25.06%) was recorded from plots treated with *Azadirachta* seed oil (1%). Three days after the treatment the percentage of visiting insect pollinators did not change in plots treated with *Pongamia* seed oil (1%), but the pollinator percentage increased in plots treated with *Azadirachta* kernel extract (5%) and *Azadirachta* leaf extract (10%). However, the percentage of visiting pollinators decreased in plots treated with the formulated product, Achook (0.8%) and *Azadirachta* seed oil (1%). Most of the botanical treatments did not have any side-effects 5 days after

treatment and there was a marginal increase in the percentage of insect pollinator intensity (1.96 to 13.73%). However, plots treated with *Azadirachta* seed oil (1%) continued to show a deterrent effect and the pollinator intensity decreased by 21.57 per cent.

From the available literature it has become increasingly evident that *Azadirachta* products are often perceived as harmless to natural enemies, pollinators and other non-target organisms. For this reason, several IPM programmes have adopted *neem* as one of the prime components. It is a common belief that botanicals might not bring about immediate mortality of pollinators after application/ contact; however, besides causing a repellent effect, botanical pesticides are potent enough to affect the normal growth and development processes in several insects, especially social insects that carry pollen and nectar to the hives where thousands of hive mates might be affected. Under such circumstances synthetic pesticides that bring about immediate kill or have a quick knock-down effect are relatively safe for social bees, as only healthy non-poisoned bees return to the hive.

The toxic effects of *Azadirachta* on soil-inhabiting and aerial natural enemies in chickpea has reportedly evinced 41 and 29 per cent population reduction of natural enemies, respectively, compared with 63 and 51 per cent when using a conventional insecticide (endosulfan). *Azadirachta indica* has also been quoted to have negatively affected the parasitization of *Helicoverpa armigera* (Hübner) larvae by *Campoletis chlorideae* Uchida up to 20 per cent (Ranga Rao *et al*., 2007). Although *neem* preparations are said to be safe for bees, they do affect the foraging behaviour and flight distances of bumble bees, the sub-lethal doses of azadirachtin affected the foraging distance of bumble bees quotes Karise *et al*. (2007). In contrast, Sontakke and Dash (1996) reported quinalphos and chlorpyrifos reduced the numbers of foraging *A. florea* after application on mustard against aphids, whereas numbers were normal after treatment with neem.

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