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TOXICITY OF CARBOSULFAN (MARSHAL 25® EC) TO NATURAL ENEMIES IN BRINJAL ECOSYSTEM

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ABSTRACT

Carbosulfan, a relatively new carbamate chemical is widely used in brinjal ecosystem owing his acclaim in managing shoot and fruit borer and sucking pests of brinjal. For integrating in IPM concepts, the toxicity/safety of carbosulfan to natural enemies *viz.*, chrysopids, coccinellids and spiders in brinjal ecosystem should be identified. A field experiment conducted to assess the level of toxicity of carbosulfan (Marshal® 25 EC) at three different doses *viz.*, 250, 500 and 1000 g a.i ha^{-1} revealed the reduction in the population of coccinellids (64 to 82.5 per cent), chrysopids (46.53 to 57.14 per cent) and spiders (33 to 71 per cent) first day after the spray indicating the toxicity of the chemical. However, the population rebounds to original number 14 days after the spray at the lowest dose (250 g a.i ha^{-1}) of carbosulfan. Hence the chemical is fairly harmless at the recommended dose and unsafe at higher doses.

INTRODUCTION

Brinjal, *Solanum melongena* Linnaeus is highly cosmopolitan and popular vegetable grown as poor man's crop in India (Sidhu and Dhatt, 2007). It is grown throughout the year under tropical and subtropical conditions and usually finds its place in common men's kitchen (Dubey *et al.,* 2014). Brinjal is attacked by more than 70 insect pests (Subbaratnam and Butani, 1982) and the pest problems in brinjal are becoming more serious because of favorable conditions which are provided by present methods of cultivation. The monoculture, overlapping of crops, dense cropping, excess use of fertilizers and pesticides, continuous availability of preferred host plants *etc.*, are some of the major reasons for pest outbreak. Insecticides provide an acceptable solution to overcome these pests, as they are highly effective, rapid in curative action and adoptable to most situations, flexible in meeting changing agronomic conditions and relatively economical. Various insecticides belonging to organochlorines, organophosphates, carbamates and synthetic pyrethroids were recommended earlier to control these pests.

Carbosulfan, (2,3-dihydro-2,2-dimethyl-7-benzo-furnanyl (di-n-butyl amino) thio methyl carbamate) a relatively new methyl carbamate insecticide is reported to be effective against insect pests of this crop. Carbosulfan (Marshal® 25 EC) is found to be very efficient in reducing the population of brinjal fruit and shoot borer as well as sucking pests (Sheeba Jasmine and Chandrasekaran, 2002) and hence the chemical is recommended for brinjal pests. Insecticides applied to manage the harmful insect pests of the crop, also kills the beneficial non-target organisms. The organochlorine and organophosphate insecticides have been reported to pose a potential threat to all types of ecosystem (Nayar *et al.,* 1992).

The indiscriminate use of pesticides has resulted in the development of resistance and resurgence in the pest besides environmental and health hazards. High intensity of insecticide sprays causes mortality of beneficial arthropods associated with predation or parasitism (Gogi *et al.,* 2006; Desneux *et al.,* 2007). Biological control of insect pests with predators and/or parasitoids is the most important and ecofriendly components of IPM (Naranjo, 2001). Recently, highly efficacious insecticides with novel mode of action are available and becoming an important tool of integrated pest management and resistance management strategies. These insecticides are required only in few grams in comparison to older class of compounds and are perceived to carry higher safety/ environmental risks (Wing *et al.,* 2000).

The insecticides applied in agroecosystem not only affect the target pest but also have adverse impact on natural enemies. The population of predators has declined by 68.4 percent during the last two decades and many parasitoids have been eliminated (Dhawan and Simwat, 1996). Therefore, before incorporating newer insecticides with novel mode of actions in IPM programmes, it is imperative to screen them for their safety to natural enemies. The reduction of natural enemies caused by the use of nonselective insecticides may invite serious consequences for the pest population dynamics. One of them is the important phenomena of resurgence and eruption of secondary pests (Gallo *et al.,* 2002). High risks of pest outbreak are expected. Before application of insecticides, it is necessary to choose a product that is efficient to pests and selective to natural enemies. Integration of selective insecticides with biological control can minimize adverse effects to natural enemies (Johnson and Tabashnik, 1999). Coccinellids, popularly known as ladybird beetles or ladybugs are the most successful group of predators. About 90 per cent of approximately 4,200 coccinellid species are considered as beneficial because of their predatory activity, mainly against homopterous insects and mites (Swaminathan *et al.,* 2010). Conservation of predators particularly coccinellids, chrysopids and spiders is essential (Zala e*t al.,* 2015). Diversified natural enemies like coccinellids, chrysopids and spiders were present in large numbers in brinjal ecosystem. Repeated chemical sprays are reducing the natural population of predators present and hence pose more risks. Keeping this in view, an attempt was made to determine the toxicity of carbosulfan and their impact on predatory coccinellids, chrysopids and spiders.

MATERIALS AND METHODS

With a view to find out the safer insecticidal application strategies of carbosulfan for natural enemies in brinjal ecosystem, a replicated and randomized field experiment was conducted to study the toxicity of carbosulfan to natural enemies at Urumandampalayam village, Vellakinaru, Coimbatore, by the variety CO-2, with five treatments replicated four times and the plot size was 20m^2. The treatment details were as follows.

T_1	Carbosulfan25EC	250g a.i.ha^{-1}
T_2	Carbosulfan25EC	500g a.i.ha^{-1}
T_3	Carbosulfan25EC	1000g a.i.ha^{-1}
T_4	Dimethoate 30EC	300g a.i.ha^{-1}
T_5	Untreated control	

Carbosulfan at the recommended dose (250 g a.i.ha^{-1}) and double (500 g a.i.ha^{-1}) and four times the dose (1000 g a.i.ha^{-1}), along with comparative chemical dimethoate 30 EC (300g a.i.ha^{-1}) and an untreated control were the different treatments imposed. For obtaining the different doses, 2 ml, 4 ml and 8 ml of carbosulfan 25 EC and 2 ml of dimethoate 30 EC were dissolved in 1 litre of water separately and these dilutions were used for field spray (Anon., 2013). First spray of insecticides was given at initiation of pests and subsequent three rounds of spraying were given in the field trials at the vegetative stage at 14 days interval commencing from 10th day after transplanting with pneumatic knapsack sprayer using 500 litres of spray fluid per hectare (Khedkar and Ukey, 2003). The number of natural enemies *viz.,* spiders, coccinellids and chrysopids were recorded to assess the toxicity of carbosulfan 25 EC prior to third application and 1, 3, 7 and 14 days after third spraying on ten randomly tagged plants per plot (Sheeba Jasmine, 2002).

RESULTS

The pooled data over periods and seasons for population of chrysopids, coccinellids, and spiders were presented in Table 1, 2 and 3. The results on the toxicity of carbosulfan 25 EC to natural enemies revealed that the chemical is unsafe.

Toxicity of carbosulfan (Marsh 25® EC) to chrysopids

Carbosulfan tested for the toxicity against chrysopids in brinjal eco system registered considerable reduction in population of chrysopids. The pre-treatment population of chrysopids ranged from 5.3 to 6.3 per 10 plants before spraying. Carbosulfan at higher dose (1000 g.a.i.ha^{-1}) recorded minimum number of 2.0 and 2.8 on 1 and 3 DAT. The level of toxicity obtained for carbosulfan at 250, 500 and 1000 g a.i.ha^{-1} were with reduction in population of 57.14 and 56.8, 51.7 and 46.53, 32.3 and 36.02 and 56.6 at 1 and 3 DAS respectively, while the toxicity level was considerably less in the lowest dose of carbosulfan, which showed a population of 9.0 per ten plants while it was 9.3 per 10 plants in the untreated check.

Toxicity of carbosulfan (Marsh 25® EC) to coccinellids

In brinjal, considerable amount of toxicity was observed on coccinellids with reduced population on 1 and 3 DAS. The population of coccinellids varied from 10.0 to 12.0 from the 10 observed plants before treating with chemicals. At 1 DAT, the higher concentration of carbosulfan (1000 g a. i. ha^{-1}) registered maximum reduction in coccinellid population (82.5%) followed by carbosulfan 500 g a.i.ha^{-1} (67.61%), and carbosulfan @250 g a.i.ha^{-1} (64.0%), which were on par. At 14 DAT, maximum population of coccinellids was noted in the untreated control which is on par with the minimum dose of carbosulfan (250 g a.i.ha^{-1}) (13.0 per 10 plants), and carbosulfan at 500 g a.i.ha^{-1} (8.0 per 10 plants). However, carbosulfan at 1000 g a.i.ha^{-1} exhibited 44.8 per cent reduction than control even at 14 DAT.

Toxicity of carbosulfan (Marsh 25® EC) to spiders

The insecticides evaluated for toxicity against spiders in brinjal ecosystem showed that there is considerable decrement in spider population in all the treatments imposed on plants. The pre-treatment population of spiders ranged from 7.3 to 8.3 per 10 plants before spraying (Table 3). The highest concentration of carbosulfan (1000g a.i.ha^{-1}) exhibited minimum number of spiders *ie.* 2.3, 3.0, 5.0 and 5.8 per 10 plants at 1, 3, 7 and 14 DAT. However at 14 DAT, maximum population was recorded in carbosulfan @ 250 g a.i.ha^{-1} (9.5 per 10 plants) which was on par with the untreated control (9.0 per 10 plants). The standard check (7.3 per 10 plants) and carbosulfan at 500 g a.i.ha^{-1} (7.0 per 10 plants), were on par, followed by maximum dose of carbosulfan (1000 g a.i.ha^{-1}) (5.8 per 10 plants). The toxicity level noticed for carbosulfan at 250, 500 and 1000 g a.i.ha^{-1} and dimethoate at 300 g a.i.ha^{-1} were with a reduction of 33.13, 24.0, 62.2, 40.2 and 71.1, 64.1, 42.4, 31.2 per cent in brinjal ecosystem on 1 and 3 DAS respectively. However, on 14 DAT the original population of spider was restored in the minimum dose of carbosulfan as in untreated check.

DISCUSSION

Toxicity of carbosulfan (Marshal 25® EC) to chrysopids

For the recommended dose of carbosulfan @ 250 g a.i.ha^{-1}, the pretreatment population of 6.0 per ten plants rebounded on 7th day from 4.0 and 5.0 per ten plants on 1st and 3rd day and increased to 9.0 per ten plants on fourteenth day and hence relatively safer on its recommended dose. But for the other two doses @ 500 and 1000 g a.i.ha^{-1}, population rebounded only on 14th day and more and hence seemed unsafe. Similar result was obtained by Rajeshwaran and

Santharam (2004) that carbosulfan was harmful to *Chrysoperla* adults when assessed through contamination method under laboratory condition. The same effect was also reported by Patel and Vyas (1985) that carbaryl at 0.15% concentration had a greater residual toxicity to the larvae of *C. carnea*. High toxicity of carbosulfan, quinalphos and monocrotophos to *Chrysoperla* sp. was reported by Srinivasan and Sundara Babu (2000).

Toxicity of carbosulfan (Marshal 25® EC) to coccinellids

The pre-treated population of 12.0 per ten plants reached the same level after carbosulfan spray only on the 14th day at the recommended dose (carbosulfan @ 250 g a.i.ha^{-1}) and hence relatively unsafe for the natural enemy. The population of coccinellids as low as 8.0 and 6.0 per ten plants, were recorded on the 14th day after spraying of carbosulfan @500 and 1000 g a.i.ha^{-1}. Similar results were reported by Maleque *et al*. (1999) who stated that cypermethrin applied at weekly intervals caused population reduction of ladybird beetles in brinjal ecosystem. It is in accordance with the findings of Rajagopal and Kareem (1983) who stated that fenvalerate (0.05%) and methamidphos were toxic to adults and larvae of *Menochilus sexmaculatus* and Sharma *et al*. (1991) who found that cypermethrin, dimethoate, monocrotophos and fenvalerate at 0.04, 0.4, 0.4 and 0.2 kg ha^{-1} respectively, were toxic to the coccinellid, *M. sexmaculatus*. Sunitha *et al*., (2004) reported dichlorvos and imidacloprid were found to be toxic to coccinellids in okra ecosystem

Toxicity of carbosulfan (Marshal 25® EC) to spiders

Carbosulfan on its recommended dose reached the pretreatment population of 8.3 per ten plants on 7th day after spray, but on 14th day and even more days when sprayed at 500 and 1000 g a.i.ha-1. Carbosulfan, irrespective of the doses were safe to spiders based on the report that even 50 per cent reduction in population is considered to be safe as reported by Dhawan (2002). Similarly, these findings were in accordance with Raman and Uthamasamy (1983) who found that carbosulfan was least toxic to spiders in cotton ecosystem. Spraying of cypermethrin 10 EC @ 0.016% was found relatively most toxic having higher mortality of coccinellids (57.3, 58.1%); braconid wasp (54.6, 61.7%) and predatory spiders (64.58, 53.09% (Tiwari *et al.,* 2007).

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