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Evaluation of impact of novel molecule, cyenopyrafen 30% SC against predatory spiders and coccinellid beetles associated with apple orchard and its phytotoxicity on apple crop

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Abstract
A field experiment was conducted to evaluate the impact of novel molecule, Cyenopyrafen 30% SC against predatory spiders and coccinellid beetles associated with apple orchard at Mukteshwar, Nainital district of Uttarakhand during 2013 and 2014. The mean percent reduction of *Coccinella* population after I and II spray @7th DAT in standard checks viz., propargite 57%EC with 41.94 and 43.61 and fenazaquin 10%EC with 38.50 and 43.27% whereas, in Cyenopyrafen 30% SC treatments @300ml/ha, 250ml/ha, 200ml/ha and 150ml/ha showed 40.85 and 36.06; 38.50 and 32.25; 27.82 and 21.79; 22.17 and 20.72%; respectively. Similarly the spiders population in standard checks i.e., fenazaquin 10% EC with 32.84% and 43.79% and propargite 57% EC with 26.52% and 38.03% whereas, in Cyenopyrafen 30% SC treatments @300ml/ha, 250ml/ha, 200ml/ha and 150ml/ha showed 30.64 and 38.42; 24.21 and 37.25; 21.89 and 32.86; 17.34 and 24.74% during I and II spray respectively.

Keywords: Cyenopyrafen, propargite, fenazaquin, apple, spiders, *Coccinella*, natural enemies

1. Introduction

Apple (*Malus domestica* Borkh) has attained the distinction of being the most important fruit crop of the North Western Himalayan region of India [5]. It is considered as the world's oldest fruit crop with a wide range of flavor and taste. In India, apple is majorly cultivated in Jammu and Kashmir, Himachal Pradesh, Uttarakhand states and parts of Arunachal Pradesh [1]. Of above states, Jammu and Kashmir hold sixty percent of annual estimated(final) apple production i.e., 2.52 lakh MT apple fruit covering an area of 2.77 lakh hectares with an average productivity of 9 MT /ha [7]. Apple being a most valued commercial crop still poor in terms of yield and quality as compared to that of the developed nations because of poor traditional cultivation and management patterns and due to a high a degree of damage done by key pests and diseases [12].

There are approximately 200 species of natural enemies are associated with apple orchards in China [10]. The major natural enemies comprises, insect predators and parasitoids, spiders, pathogenic organisms, insectivorous birds and so on, playing an important role in regulating major pests in the orchard [10]. However, the use of chemical control of insect pests in apple orchards has been an old practice, which led to natural enemy mortality, pest resurgence, and resistance development, as well causing serious environmental pollution [3].

Cyenopyrafen is a novel insecticide belongs to beta-ketonitrile acaricides group developed and commercialized by Otsuka Agri Techno and Nissan Chemicals in 2007 and 2009 respectively [6]. It is being pro-acaricide, activated by hydrolysis, acts as a potential inhibitor of mitochondrial complex II and represents a new mode of action [6].

It should be noted that in apple orchards, the maximum populations of spider mites usually occur in July and then decrease because of natural processes, as well as the activity of predatory mites or the use of selective pesticides [4]. Spraying of acaricides and insecticides adversely affect natural enemies populations while going to manage apple pests. So the present investigation "Evaluation of impact of novel molecule, Cyenopyrafen 30% SC against predatory spiders and coccinellid beetles associated with apple orchard" was carried out to find bioefficacy of acaricide on natural enemies thereby relative safety to bioagents present in apple orchard.

2. Material and methods

The field experiment was conducted in the plot size of 10x20m with a plant spacing of 5x3m during 2013 and 2014 at Mukteshwar apple (7-year-old) orchards and Department of Entomology, GBPUA&T Pantnagar. It is situated in high Kumaon hills in Nainital district of Uttarakhand at an altitude of 2286 meters (7500 feet) above sea level and 29.47 ºN and 79.65 ºE. The experiment uses seven treatments for bio-efficacy and 1 treatment for phytotoxicity evaluation.

To study the impact of cyenopyrafen 30% SC on natural enemies the acaricide applied on the crop after mite infestation twice at 15 days interval. The population of *Coccinella* spp. and spiders prevailing in the experimental plots were recorded on 5 twigs per tree and on 3 trees per replication before the first spray, after 1 and 7 days of each spray per replication before I spray and after 1, 3, 7, 10 and 14 days of each spray [11]. Based on the data percent reduction in population over control was also calculated out. Fruit yield per plot was recorded at harvest.

For phytotoxicity evaluation cyenopyrafen 30% SC was also applied @ 600 ml/ha. Visual observations on phytotoxicity parameters viz leaf injury on tips/surface, wilting, vein clearing, necrosis, epinasty and hyponasty were recorded after 1, 3, 7, 10 and 14 days of each spray for all the treatments (based on 0-10 scale 0=0%, 1=1-10%, 2=11-20%, 3=21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71=80%, 9=81-90%, 10=91-100 per cent) [14].

2.1 Statistical Analysis

All the data obtained in different treatments were subjected to statistical analysis by using Analysis of Variance technique using STPR3 software.

3. Results and Discussion

The pooled data of *coccinella* and spiders for two years viz., 2013 and 2014 are presented in Table 1 and Table 2. The pooled data from Table 1 revealed that the mean reduction of *coccinella* population at 7th day during I spray was maximum in treatment propargite 57% EC @ 1000 ml/ha with 41.94% followed by Cyenopyrafen 30% SC @300ml/ha with 40.85% followed by Cyenopyrafen 30% SC @250ml/ha and fenazaquin 10% EC @ 400 ml/ha with 38.50% and 38.36% respectively, while least was found in Cyenopyrafen 30% SC @200ml/ha and Cyenopyrafen 30% SC @150ml/ha with 27.82% and 22.17% respectively. During II spray at 7th day the mean reduction was observed in treatment propargite 57% EC @ 1000 ml/ha with 43.61% followed by fenazaquin 10% EC @ 400 ml/ha with 43.27%, Cyenopyrafen 30% SC @300ml/ha with 36.06%, Cyenopyrafen 30% SC @250ml/ha with 32.25%, Cyenopyrafen 30% SC @200ml/ha with 21.79% and least was observed in Cyenopyrafen 30% SC @150ml/ha with 20.72% respectively. However, the reduction was observed in all treatments the reduction was more in standard checks and Cyenopyrafen 30% SC @300ml/ha and are comparable whereas in other treatments the reduction was significantly less and shown less effect on *coccinella* population.

The pooled data from Table 2 revealed that the mean reduction of spider population at 7th day during I spray shown that the mean maximum reduction was found in the treatment fenazaquin 10% EC @ 400 ml/ha with 32.84% followed by Cyenopyrafen 30% SC @300ml/ha with 30.64%, propargite 57% EC @ 1000 ml/ha with 26.52%, Cyenopyrafen 30% SC @250ml/ha 24.21%, Cyenopyrafen 30% SC @200ml/ha with 21.89% and least was found in and Cyenopyrafen 30% SC @150ml/ha with 17.34% respectively. Whereas, during II spray at 7th day the mean reduction of spider population was observed in treatment fenazaquin 10% EC @ 400 ml/ha with 43.79% followed by Cyenopyrafen 30% SC @300ml/ha with 38.42%, propargite 57% EC @ 1000 ml/ha with 38.03%, Cyenopyrafen30% SC @250ml/ha 37.25%, Cyenopyrafen 30% SC @200ml/ha with 32.86% and least was found in and Cyenopyrafen 30% SC @150ml/ha with 24.74% respectively. Though the reduction was observed in all treatments the reduction was more in standard checks and Cyenopyrafen 30% SC @300ml/ha and are comparable whereas in other treatments the reduction was significantly less and shown less effect on spiders population.

The present investigation lacks sufficient researches and reviews for discussion as the present was conducted using newer miticide molecule, Cyenopyrafen 30SC, to study of effect of Cyenopyrafen 30SC on apple natural enemies. However, few research papers related to present experiment were discussed below.

Cyflumetofen has been tested against a wide range of beneficial arthropods, including predatory mites. The results from standard laboratory bioassays indicate that cyflumetofen does not impact a variety of non-target arthropod species, including parasitic wasps, predatory mites, predatory bugs, ladybird beetles, rove beetles and lacewings, when the organisms are exposed to fresh residues on inert substrates. Due to its highly selective nature, cyflumetofen will be a good fit in integrated pest management programs, or in programs that release beneficial mites, as it is likely to have little impact on the predatory mite populations [13].

[8] also reported that the cyflumetofen, belonging to the same group of cyenopyrafen i.e., beta-ketonitrile, showed no effect or limited impact on beneficial arthropods and natural enemies, such as predatory mites, parasitoid wasps, and predatory insects, Meantime they also reported that there was no phyto-toxicity and safe to target crops. Thus supports present research in terms of limited impact on natural enemies and safety to target crop.

[9] Conducted a field experiment to investigate the efficacy of cyflumetofen 20 EC of against the red spider mite (*Oligonychus coffeae*) of tea crop in Vandiperiyar, Kerala, India, during two seasons and found that the tested rates of cyflumetofen 20 EC were also non-phytotoxic to tea, though the crop is tea this relatively supports present investigation in terms of Non-phytotoxic.

Table 1: Effect of various treatments on *Coccinella* spp (Pooled data of two years)

Treatments	Dose ml/ha	Population of *Coccinella* spp./tree									
		BS	1DAT	% reduction over PTC/control	7DAT	% reduction over PTC/control	BS	1DAT	% reduction over PTC/control	7DAT	% reduction over PTC/control
Cyenopyrafen 30% SC	150	12.50 (3.61)	10.92 (3.38)	15.32	10.80 (3.36)	22.17	11.32 (3.44)	10.75 (3.37)	9.84	10.20 (3.27)	20.72
Cyenopyrafen 30% SC	200	12.09 (3.55)	10.09 (3.25)	20.72	9.98 (3.24)	27.82	10.45 (3.31)	9.60 (3.17)	13.14	9.30 (3.15)	21.79
Cyenopyrafen 30% SC	250	14.04 (3.81)	10.75 (3.54)	31.57	10.70 (3.35)	38.50	10.3 (3.29)	9.85 (3.28)	20.38	9.35 (3.17)	32.25
Cyenopyrafen 30% SC	300	13.21 (3.70)	10.17 (3.27)	30.92	9.90 (3.22)	40.85	9.5 (3.16)	9.12 (3.10)	29.47	9.05 (3.09)	36.06
Fenazaquin 10% EC	400	12.13 (3.55)	9.89 (3.22)	23.51	9.25 (3.12)	38.36	8.45 (2.99)	8.85 (3.06)	31.17	8.45 (2.99)	43.27
Propargite 57% EC	1000 ml/ha	14.38 (3.86)	11.30 (3.44)	41.28	10.69 (3.33)	41.94	8.70 (3.05)	9.12 (3.10)	34.39	8.90 (3.07)	43.61
Control	-	13.50 (3.74)	14.71 (3.9)	0.00	14.25 (3.84)	-	14.05(3.81)	14.00 (3.80)	0.00	14.60 (3.89)	0.00
SEM		0.0018	0.0017		0.0023		0.136	0.0026		0.0031	
CD (5%)		0.0054	0.0052		0.007		0.419	0.0081		0.0095	

PTC- Pre Treatment Control DAT – Days After Treatment

Table 2: Effect of various treatments on spider population (Pooled data of two years)

S. No.	Treatment	Dose ml/ha	Population of *Spiders*/tree									
			PTC	1DAT	% reduction over PTC/control	7DAT	% reduction over PTC/control	PTC	1DAT	% reduction over PTC/control	7DAT	% reduction over PTC/control
1	Cyenopyrafen 30% SC	150	4.30 (2.19)	4.20 (2.17)	5.82	4.35 (2.20)	17.34	4.50 (2.24)	4.20 (2.17)	5.93	3.80 (2.07)	24.74
2	Cyenopyrafen 30% SC	200	4.21 (2.17)	4.12 (2.15)	5.62	4.10 (2.14)	21.89	4.20 (2.17)	3.90 (2.10)	6.48	3.33 (1.96)	32.86
3	Cyenopyrafen 30% SC	250	4.17 (2.16)	4.02 (2.13)	7.34	3.99 (2.12)	24.21	4.30 (2.19)	3.90 (2.10)	9.01	3.30 (1.95)	37.25
4	Cyenopyrafen 30% SC	300	4.38 (2.21)	4.12 (2.15)	9.89	3.98 (2.12)	30.64	4.10 (2.14)	3.50 (2.00)	15.82	3.12 (1.90)	38.42
5	Fenazaquin 10% EC	400	4.42 (2.22)	4.15 (2.16)	10.09	3.95 (2.11)	32.84	4.30 (2.19)	3.46 (1.99)	22.87	3.15 (1.91)	43.79
6	Propargite 57% EC	1000	3.88 (2.09)	3.65 (2.04)	9.86	3.64 (2.03)	26.52	3.80 (2.07)	3.24 (1.93)	15.96	2.90 (1.84)	38.03
7	Control	-	4.17 (2.16)	4.31 (2.20)	0.00	4.95 (2.33)	0.00	5.26 (2.40)	5.20 (2.42)	0.00	5.54 (2.46)	0.00
	SEM		0.0011	0.0013		0.0020		0.0018	0.0037		0.0032	
	CD (5%)		0.0034	0.0040		0.0062		0.0057	0.012		0.010	

PTC- Pre Treatment Control DAT – Days After Treatment

4. Conclusion

Two sprays of Cyenopyrafen 30% SC @200, 250 and 300 ml/ha at 15 days interval showed promising control and better control over standard checks of mites in apple crop but less on the natural enemy population. The Cyenopyrafen was also tested for phytotoxic effect up to 600 ml/ha and shown no phytotoxic effect on apple crop.

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