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Studies on effect of acaricides on natural enemies of European red mite *Panonychus ulmi* (Koch) in North Kashmir

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Abstract
The studies on effect of acaricides on natural enemies of European Red Mite *Panonychus ulmi* (Koch) in North Kashmir were carried out during 2017 at Pattan (Baramulla). Seven acaricides and one horticulture mineral oil were evaluated at a single concentration *viz.*, fenazaquin 10 EC @ 0.004, Propargite 57 EC @ 0.057, hexythiazox 5 EC @ 0.002, spiromesifen 240 EC @ 0.096, fenpyroximate 5 EC @ 0.005, ethion 50 EC @ 0.05, clothianidin 50 WDG @ 0.007, arbofine extra @ 0.75 and water as check against the pest infesting on apple trees during second week of July. The effect on natural enemies *viz.*, *Stethorus punctum* and *Amblyseius* spp and was observed. Regarding natural enemies, the highest per cent mortality of 78.33 and 76.52 in respect of natural enemies *viz.*, *S. punctum* and *Amblyseius* spp was observed in fenazaquin @ 0.004 per cent whereas, the minimum per cent mortality 61.67 was caused by arbofine extra (HMO) @ 0.75 per cent in *S. Punctum* and 64.20 per cent in *Amblyseius* spp, respectively.

Keywords: Apple, *Stethorus punctum*, *Amblyseius* spp, pesticides, HMO, mortality

Introduction
Apple **(***Malus* × *domestica* Borkh) belongs to the family Rosaceae which is believed to have been originated in temperate region of Western Asia between Black sea & Caspian sea and the major apple producing countries in the world are China, United States, Turkey, Poland, India, Italy, Brazil, Russia, France, Japan, Germany and USSR (Thumariakannan *et al*., 2010) [10]. The European red mite, *P. ulmi* has emerged as the most nefarious and pervasive pests since its outbreak in 1993 in apple orchards of Kashmir valley and continues to pose a threat for successful production of apples (Anonymous, 2007) [3]. Presently more than 80 per cent of the orchards in Jammu And Kashmir State are infested with this pest (Anonymous, 2001) [2].
Primarily due to indiscriminate use of broad spectrum of acaricides without knowing their efficacy as well as safety to natural enemies of phytophagous mites have degraded environment and reduces the income of the growers. Further the outbreak of mite pest has been attributed to the indiscriminate and excessive use of broad spectrum insecticides against the commonly found insect pests in the valley (Anonymous, 1993) [1] which resulted in the destruction of their natural enemies leading to their resurgence (Zaki and Chan, 2001) [10]. Therefore, management of the mite pest is significantly important so as to maintain its population below economic threshold level. The use of pesticides in pest management has been a long history and have been used against wide spectrum of pests on variety of crops over long years. Since, the role of European red mite is significant not only in deteriorating the quality of apple but also in reducing the fruit production.

Material and Methods
The methodology for recording the impact of different acaricides/ Horticultural mineral oil (HMO) against natural enemies *viz.*, *Stethorus punctum* and *Amblyseius* spp. Twenty seven apple trees of uniform shape, size, age (25 years) and vigour were randomly selected and tagged for recording the experimental observations. In total of 24 leaves/tree were observed for population count of natural enemies. The pretreatment count was taken 1 day before the treatment under stereo microscope. The post treatment counts were conducted at an interval of 1, 5,7,10 and 15 days after treatment (DAT).

Results and Discussion

Evaluation of acaricides/ HMO against *Stethorus punctum*

The perusal of data in Table 1 indicated that population of *S. punctum*/leaf ranged from 1.52-2.38 in pre treatment count whereas, post treatment count of 1 to 15 DAT from 0.14-0.53; 0.24-0.84; 0.31-1.01; 0.18-0.66; 0.29-0.93; 0.26-0.97;0.45-1.04 and 0.55-1.22 in fenazaquin, propargite, hexythiazox, spiromesifen, fenpyroximate, ethion, clothianidin and arbofine extra, respectively. The findings obtained on evaluation of acaricides/HMO against the *S. punctum* revealed that at 1DAT the predator mite population ranged from 0.53 to 1.22 with minimum population of 0.53/leaf recorded in fenazaquin and maximum population 1.22/leaf in arbofine extra. The per leaf population at 5 DAT ranged between 0.42 to 1.10 in different treatments compared to 2.15 in control. It was minimum (0.42/leaf) and maximum (1.10/leaf) intreatments of fenazaquin and arbofine extra, respectively. Similar observations were recorded at 7, 10 and 15 DAT.

While computing the per cent cumulative mortality of this predator of *P. ulmi* revealed the range of mortality as 78.33 to 61.67 with minimum (61.67) and maximum (78.33) in the arbofine extra and fenazaquin, respectively Table 2. The present findings could not compared with the earlier records of the different scientists as no any particular findings have been observed while scanning the literature. However, population of natural enemies (Chrysopids, anthocorids, predatory thrips and predatory mites) was reduced significantly in higher doses of fenazaquin @ 0.06 and 0.08 per cent (Mohapatra *et al*., 2012) [6]. Similarly, Maroufpoor *et al*. (2016) [5] while examining the effect of acaricides on the life table parameter of *N. californicus* feeding on *P. ulmi* found significant effort of fenazaquin and spirodiclofen on fecundity, oviposition, longevity but, not on development duration of the predator.

Evaluation of acaricides/ HMO against *Amblyseius* spp

The perusal of data in Table 3 indicated that population of *Amblyseius* spp/ leaf ranged from 0.06-0.26, 0.11-0.26, 0.12-0.25, 0.08-0.24, 0.14-0.34, 0.12-0.32, 0.17-0.34 and 0.17-0.34 in respect of fenazaquin, propargite, hexythiazox, spiromesifen, fenpyroximate, ethion, clothianidin and arbofine extra compared to 0.63-0.70 control 1 to 15 DAT. The findings revealed that at 1 DAT the population ranged from 0.24 to 0.34/leaf with minimum (0.24) and maximum (0.34) in fenazaquin and arbofine extra, repectively. However, the treatments fenazaquin, propargite, hexythiazox and spiromesifen were statistically at par in minimizing the population. Similarly treatments *viz.*, fenpyroximate, ethion, clothianidin and arbofine extra were also statistically at par in reducing the predator population. Similar observations were recorded during rest of the observational days.

Data in Table 4 revealed that similarly as in case of *S. punctum* the per cent cumulative mortality of *Amblyseius* spp was found to be minimum in arbofine extra(64.20) and maximum in fenazaquin (76.52). The available literature revealed scanty information pertaining to this parameter. However, Stanford and Herbert (1967) [7] reported dicofol as much more toxic to the predator than the prey which resulted in complete elimination of *a fallacis*. But, hexythiazox was found to be effective in reducing the predatory phytoseiid mite when spayed in July (Tuovinen, 1990) [9] which support our findings of minimizing the population of this predatory mite by 72.06% when hexythiazox was applied during the subsequent period. Similarly, the present findings of minimizing effect of fenazaquin on this predatory mite do find favour with the earlier observations of Mohapatra *et al*. (2012) [6] who reported significant reduction of different natural enemies by fenazaquin. The cyhexyatin and pyriproxyfen were also found to be harmful for the nymphs and adults of *N. californicus* while hexythiazox and chlorantranilprole were harmless (Kaplan *et al.*, 2012) [4].

Table 1: Effect of various acaricides/HMO against natural enemies (*Stethorus punctum*) of European Red Mite (*Panonychus ulmi* Koch) at Pattan (Baramulla) 2017

Name of Acaricides / HMO	Conc. (%)	Dosage (ml/gm/100 lit of water)	*Pretreatment count/ leaf	*Population of *Stethorus punctum* (Days After Treatment)					Cumulative mean population of *Stethorus punctum*
				1	5	7	10	15	
Fenazaquin 10 EC	0.004	40	1.52	0.53	0.42	0.32	0.23	0.14	0.33
			(1.58)	(0.73)^{a}	(0.65)^{a}	(0.56)^{a}	(0.48)^{a}	(0.37)^{a}	
Propargite 57 EC	0.057	100	1.82	0.84	0.64	0.50	0.35	0.24	0.51
			(1.68)	(0.92)^{c}	(0.80)^{c}	(0.71)^{b}	(0.59)^{c}	(0.49)^{c}	
Hexythiazox5 EC	0.002	40	2.12	1.01	0.86	0.72	0.60	0.31	0.7
			(1.76)	(1.00)^{d}	(0.93)^{e}	(0.85)^{c}	(0.77)^{e}	(0.56)^{d}	
Spiromesifen 240 SC	0.096	40	1.64	0.66	0.55	0.49	0.29	0.18	0.43
			(1.63)	(0.81)^{b}	(0.74)^{b}	(0.70)^{b}	(0.54)^{b}	(0.42)^{b}	
Fenpyroximate 5 EC	0.005	100	1.94	0.93	0.76	0.65	0.57	0.29	0.64
			(1.72)	(0.96)^{cd}	(0.87)^{d}	(0.81)^{c}	(0.75)^{e}	(0.54)^{cd}	
Ethion 50 EC	0.05	100	2.22	0.97	0.78	0.67	0.45	0.26	0.63
			(1.80)	(0.98)^{cd}	(0.88)^{d}	(0.82)^{c}	(0.67)^{d}	(0.51)^{cd}	
Clothianidin 50 WDG	0.007	14	2.18	1.04	0.94	0.86	0.68	0.45	0.79
			(1.70)	(1.02)^{d}	(0.97)^{f}	(0.93)^{d}	(0.82)^{f}	(0.67)^{e}	
Arbofine extra (HMO)	0.75	750	2.18	1.22	1.10	1.02	0.93	0.55	0.96
			(1.70)	(1.10)^{e}	(1.05)^{g}	(1.01)^{e}	(0.96)^{g}	(0.74)^{f}	
Control (Water spray)	-		2.38	2.10	2.15	2.22	2.24	2.26	2.19
			(1.92)	(1.45)^{f}	(1.47)^{h}	(1.49)^{f}	(1.50)^{h}	(1.52)^{g}	
Sem			0.04	(1.10)	(1.05)	(1.01)	(0.96)	(0.74)	
C.D. ($P \leq 0.05$)			0.09	0.06	0.03	0.04	0.03	0.05	

*Mean of 3 replicates and each replicate is a mean of 24 observations

Figures in parenthesis indicates square root transformed values

The values in individual columns superscripted by similar letter(s) do not differ significantly at P=0.05

Table 2: Effect of various acaricides/HMO against natural enemies (*Stethorus punctum*) of European Red Mite (*Panonychus ulmi* Koch) at Pattan (Baramulla) 2017

Name of Acaricides / HMO	Conc. (%)	Dosage (ml/gm/100 lit of water)	*Pretreatment count/ leaf	Per cent mortality of *Stethorus punctum* (Days After Treatment)					Per cent Cumulative mean mortality of *Stethorus punctum*
				1	5	7	10	15	
Fenazaquin 10 EC	0.004	40	1.52	65.24	72.34	78.32	85.12	90.64	78.33
				(53.86)^{h}	(58.24)^{h}	(62.22)^{i}	(67.30)^{i}	(72.17)^{g}	
Propargite 57 EC	0.057	100	1.82	54.12	64.78	72.66	80.65	86.94	71.83
				(47.35)^{e}	(53.57)^{f}	(58.44)^{h}	(63.88)^{g}	(68.79)^{d}	
Hexythiazox 5 EC	0.002	40	2.12	52.54	59.66	65.99	71.89	85.32	67.08
				(46.44)^{d}	(50.54)^{d}	(54.29)^{d}	(57.95)^{e}	(67.47)^{c}	
Spiromesifen 240 SC	0.096	40	1.64	59.54	66.32	70.45	82.16	89.12	73.52
				(50.48)^{g}	(54.51)^{g}	(57.04)^{g}	(65.00)^{h}	(70.72)^{f}	
Fenpyroximate 5 EC	0.005	100	1.94	52.12	60.65	66.78	70.75	84.99	67.06
				(46.20)^{c}	(51.13)^{e}	(54.79)^{e}	(57.24)^{d}	(67.16)^{c}	
Ethion 50 EC	0.05	100	2.22	56.22	65.12	69.67	78.86	88.20	71.61
				(48.56)^{f}	(53.59)^{f}	(56.61)^{f}	(62.62)^{f}	(69.90)^{e}	
Clothianidin 50 WDG	0.007	14	2.18	52.45	56.98	60.76	68.97	79.56	63.74
				(46.32)^{cd}	(48.98)^{c}	(51.20)^{c}	(56.12)^{c}	(61.71)^{b}	
Arbofine extra (HMO)	0.75	750	2.18	51.67	55.65	59.67	63.22	78.12	61.67
				(45.92)^{b}	(48.21)^{b}	(50.56)^{b}	(52.66)^{b}	(62.10)^{b}	
Control (Water spray)	-		2.38	11.89	9.67	6.67	6.02	5.12	7.87
				(20.10)^{a}	(18.08)^{a}	(14.96)^{a}	(14.22)^{a}	(13.11)^{a}	
Sem				0.08	0.11	0.10	0.09	0.23	
C.D. ($P \leq 0.05$)				0.20	0.35	0.30	0.25	0.51	

*Mean of 3 replicates and each replicate is a mean of 24 observations
Figures in parenthesis indicates arc sine transformed values
ERM= European Red Mite
The values in individual columns superscripted by similar letter(s) do not differ significantly at P=0.05

Table 3: Effect of various acaricides/HMO against natural enemies (*Amblyseius* spp) of European Red Mite (*Panonychus ulmi* Koch) at Pattan (Baramulla) 2017

Name of Acaricides / HMO	Conc. (%)	Dosage (ml/gm/100 lit of water)	*Pretreatment count/leaf	*Population of *Amblyseius* spp (Days After Treatment)					Cumulative mean population of *Amblyseis* spp
				1	5	7	10	15	
Fenazaquin 10 EC	0.004	40	0.69 (0.83)	0.26	0.20	0.16	0.10	0.06	0.15
				(0.51)^{a}	(0.45)^{a}	(0.40)^{a}	(0.32)^{a}	(0.24)^{a}	
Propargite 57 EC	0.057	100	0.72 (0.85)	0.26	0.24	0.18	0.14	0.11	0.19
				(0.51)^{a}	(0.49)^{ab}	(0.42)^{a}	(0.37)^{b}	(0.33)^{c}	
Hexythiazox5 EC	0.002	40	0.60 (0.77)	0.25	0.22	0.18	0.13	0.12	0.17
				(0.50)^{a}	(0.47)^{a}	(0.42)^{a}	(0.36)^{ab}	(0.35)^{cd}	
Spiromesifen 240 SC	0.096	40	0.67 (0.82)	0.24	0.21	0.16	0.12	0.08	0.16
				(0.49)^{a}	(0.46)^{a}	(0.40)^{a}	(0.35)^{ab}	(0.28)^{b}	
Fenpyroximate 5 EC	0.005	100	0.70 (0.84)	0.34	0.28	0.25	0.21	0.14	0.24
				(0.58)^{b}	(0.53)^{b}	(0.50)^{b}	(0.46)^{c}	(0.37)^{d}	
Ethion 50 EC	0.05	100	0.80 (0.89)	0.32	0.27	0.22	0.17	0.12	0.21
				(0.56)^{b}	(0.52)^{b}	(0.46)^{b}	(0.38)^{b}	(0.35)^{cd}	
Clothianidin 50 WDG	0.007	14	0.71 (0.84)	0.34	0.29	0.25	0.22	0.17	0.25
				(0.58)^{b}	(0.54)^{b}	(0.50)^{b}	(0.47)^{c}	(0.41)^{e}	
Arbofine extra (HMO)	0.75	750	0.71 (0.84)	0.34	0.29	0.25	0.23	0.17	0.27
				(0.58)^{b}	(0.54)^{b}	(0.50)^{b}	(0.48)^{c}	(0.41)^{e}	
Control (Water spray)	-		0.72 (0.85)	0.63	0.65	0.67	0.68	0.70	0.67
				(0.79)^{c}	(0.81)^{c}	(0.82)^{c}	(0.82)^{d}	(0.84)^{f}	
Sem				0.01	0.02	0.01	0.01	0.01	
C.D. ($P \leq 0.05$)				0.04	0.05	0.06	0.04	0.03	

*Mean of 3 replicates and each replicate is a mean of 24 observations
Figures in parenthesis indicates square root transformed values
The values in individual columns superscripted by similar letter(s) do not differ significantly at P=0.05

Table 4: Effect of various acaricides/HMO against natural enemies (*Amblyseius* spp) of European Red Mite (*Panonychus ulmi* Koch) at Pattan (Baramulla) 2017

Name of Acaricides / HMO	Conc. (%)	Dosage (ml/gm/100 lit of water)	*Pretreatment count / leaf	Percent mortality of *Amblyseius*spp (Days After Treatment)					Per cent Cumulative mean mortality of *Amblyseius* spp
				1	5	7	10	15	
Fenazaquin 10 EC	0.004	40	0.69	62.34	69.32	76.24	84.78	89.94	76.52
				(52.13)^{f}	(56.36)^{g}	(60.82)^{g}	(67.03)^{h}	(71.49)^{i}	
Propargite 57 EC	0.057	100	0.72	64.70	66.98	74.67	80.32	85.14	74.36
				(53.64)^{g}	(54.90)^{q}	(59.76)^{f}	(63.66)^{f}	(67.33)^{f}	

Hexythiazox 5 EC	0.002	40	0.60	58.14 (49.68)[d]	63.95 (53.08)[d]	70.54 (57.12)[d]	78.45 (62.32)[e]	84.22 (66.60)[e]	72.06
Spiromesifen 240 SC	0.096	40	0.67	64.45 (53.39)[g]	68.58 (55.90)[f]	76.12 (60.74)[g]	82.45 (65.23)[g]	88.76 (70.40)[h]	76.07
Fenpyroximate 5 EC	0.005	100	0.70	54.33 (47.48)[c]	59.52 (50.48)[c]	63.78 (52.99)[b]	69.56 (56.51)[d]	80.65 (63.90)[d]	65.57
Ethion 50 EC	0.05	100	0.80	59.87 (50.68)[e]	66.87 (54.85)[e]	72.67 (58.49)[e]	79.22 (62.88)[e]	85.76 (67.82)[g]	72.88
Clothianidin 50 WDG	0.007	14	0.71	52.87 (46.64)[b]	58.67 (49.99)[b]	66.32 (54.54)[c]	68.67 (55.98)[c]	76.56 (60.04)[b]	64.46
Arbofine extra (HMO)	0.75	750	0.71	52.86 (46.63)[b]	59.99 (50.75)[c]	64.32 (53.32)[b]	67.28 (55.09)[b]	75.76 (60.50)[c]	64.20
Control (Water spray)	-		0.72	12.54 (20.75)[a]	9.54 (18.01)[a]	6.62 (14.96)[a]	5.81 (13.97)[a]	4.88 (12.79)[a]	7.88
Sem				0.12	0.10	0.14	0.13	0.09	
C.D. ($P \leq 0.05$)				0.41	0.35	0.45	0.33	0.28	

*Mean of 3 replicates and each replicate is a mean of 24 observations
Figures in parenthesis indicates arc sine transformed values
The values in individual columns superscripted by similar letter(s) do not differ significantly at P=0.05

Conclusion

The highest per cent mortality of 78.33 and 76.52 in respect of natural enemies viz., *S. punctum* and *Amblyseius* spp was observed by fenazaquin 10 EC @ per cent.

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