



Bio-efficacy of Fenazaquin 20 SC against European Red Mite, *Panonychus ulmi* (Acari: Tetranychidae) on Apple in Kashmir, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Efficacy studies were conducted during June-July in 2017 and 2018 at two locations in district Baramulla of Jammu and Kashmir against the phytophagous mite *Panonychus ulmi* (Koch) in apple orchards. The test molecule Fenazaquin 20 SC at the dosages of 15, 20 and 25 ml along with standard check Hexythiazox 5.45 EC and Fenazaquin 10 SC at 40 ml per 100 litre of water were evaluated against *Panonychus ulmi*. After fifteen days of spray, maximum 90.45 and 87.99 per cent ERM mortality of was obtained from Fenazaquin 20 SC @ 25 ml in both the years at location Ferozpora, Rafiabad; whereas, at another location Chitkak (Handwara), Kupwara, highest ERM mortality of 84.95 and 90.18 per cent was recorded during both the respective years. The least mortality of natural enemies Coccinellids (pooled for two years) as 23.32 and 22.91 per cent was recorded with the test chemical Fenazaquin 20 SC @ 15 ml per litre of water; whereas, highest mortality of 32.09 and 30.46 was recorded with test molecule @ 25 ml. in Ferozpora, Rafiabad; and

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Chitkak (Handwara), Kupwara. Similarly, the least mortality of *Amblyseius* spp. as 34.50 and 33.38 per cent too was recorded with the Fenazaquin 20 SC @ 15 ml per litre of water. The highest yield of apples was recorded with application of Fenazaquin 20 EC @ 25ml in both the locations.

Keywords: Apple; *Panonychus ulmi*; fenazaquin 20 SC; hexythiazox 5.45 SC; efficacy; predators; safety.

1. INTRODUCTION

Apple is considered as the important temperate fruit in the Kashmir valley and is the mainstay of Horticulture industry. The apple crop is attacked by number of insect pests; amongst them San Jose scale (SJS), *Quadraspidiotus perniciosus* and European red mite (ERM), *Panonychus ulmi* are considered as the major insect pests infesting the crop. The two major mite pests of apple in north western Himalayas are the European red mite *Panonychus ulmi* (Koch) and two spotted spider mite, *Tetranychus urticae* (Koch). Both immature and adult stages of European red mite puncture the tissues of the leaves and feed on plant sap. Heavily infested leaves become dull green, brownish yellow or bronzed giving a burnt appearance to orchards [1]. Severe infestation results in early dropping of leaves, retarded growth, weakened & reduced fruit buds and fruit set, reduced size of fruits and premature fruit drop in subsequent years. The damaged leaves are exposed to secondary infection of fungal diseases chiefly *Alternaria* blight causing more potential loss to the growers [2]. In nature, phytophagous mites are kept under check by different predators such as predatory mites, *Chrysoperla* larvae, *Stethorus* beetles and predatory thrips etc [3]. Khajuria and Sharma [4] reported the phytoseiid mite *Amblyseius fallacis* (Garman) to suppress mites in apple. Phytoseiid mites are an important component of IPM by virtue of their ability to feed on alternate prey and survive at low prey mite densities [5]. In recent past, indiscriminate use of insecticides has often been attributed for mite outbreaks. Though, numerous acaricides are being recommended for the effective mite management [6], but with the passage of time many of these acaricides have become obsolete either due to ban or their non-production. Besides, associated natural enemies are also adversely affected due to indiscriminate chemicals usage and exposure to manage phytophagous mites [7]. Therefore, the newer acaricides against phytophagous mites be evaluated regularly under field conditions to appreciably keep their population below threshold levels. Keeping this in view, the

bioefficacy of newer molecule Fenazaquin 20 SC at dosages of 15, 20 and 25 ml per 100 litres of water was evaluated against phytophagous mites along with their safety to natural enemies in apple orchards.

2. MATERIALS AND METHODS

The field trials were conducted at two different locations i.e. Government Apple orchard, Chitkak, (Handwara) Kupwara; and Ferozpora, Rafiabad, Baramulla, Kashmir (J&K) during the years 2017 and 2018. The selected orchard had previous history of European Red Mites (ERM) infestation. The ERM population was counted on 20 leaves from all the four directions (one each from northern, southern, eastern and western side of the tree's periphery) of each selected tree, 2-3 hours before treatment and at subsequent post count intervals of 1, 5, 7, 10 and 15 days after the spray application. The trials were laid in a randomized block design (RBD). Each treatment was replicated thrice. The test molecule Fenazaquin 20 SC was sprayed at three different concentration of 15, 20, 25 ml per 100 liters of water along with standard check Fenazaquin 10 SC and Hexythiazox 5.45 EC each at 40 ml per 100 liters of water. Spraying was done by high volume sprayer @ 10 litres per tree. The data pertaining to phytotoxicity were recorded at 1, 3, 5, 7, 10 and 15 days after treatment application. Similarly, the observations on natural enemies were also recorded 1 day before spraying and 1, 3, and 7 days after spray. The phytotoxicity data on chlorosis, necrosis, wilting, scorching, hyponasty and epinasty were recorded after 1, 3,5,7, 10 and 15 days after spray using (1-10) scale at three concentrations i.e. @ 20, 40 and 80 ml per 100 litres of water. Yield was also calculated on the basis of A-Grade Apple boxes/ tree, treatment wise at time of crop harvest.

3. RESULTS AND DISCUSSION

The highest mortality of European red mite (ERM) as 90.45 and 87.99 per cent was recorded with the application of Fenazaquin 20

Table 1. Bio-efficiency of fenazaquin 20 SC against European red mite (*Panonychus ulmi*) on red delicious variety of apple at Ferozpura, Rafiabad, Baramulla, during 2017-2018

Coded molecule	Concentration (Per 100 lit. of water)	Pre-treatment count	Percent mean mortality of <i>Panonychus ulmi</i>									
			Post count observation (DAT)									
			1 st		5 th		7 th		10 th		15 th	
			2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Fenazaquin 20 SC	15 ml	16.59	44.36 (41.78)	42.06 (38.30)	55.13 (47.96)	52.08 (43.76)	69.22 (56.33)	67.62 (52.40)	75.96 (60.66)	77.50 (58.43)	80.81 (64.05)	80.00 (63.46)
Fenazaquin 20 SC	20 ml	16.6	51.52 (45.89)	51.56 (43.47)	58.10 (49.68)	61.72 (49.05)	76.46 (57.78)	73.97 (56.19)	83.99 (66.44)	81.14 (60.87)	87.25 (69.11)	83.95 (66.41)
Fenazaquin 20 SC	25 ml	16.33	56.63 (48.83)	53.42 (44.48)	61.60 (51.73)	60.13 (48.16)	79.71 (63.25)	76.05 (57.50)	86.93 (68.84)	84.08 (62.98)	90.45 (72.03)	87.99 (69.75)
Hexythiazox 5.45 EC	40 ml	15.06	42.74 (40.84)	43.30 (38.98)	51.84 (46.07)	51.87 (43.64)	68.49 (55.87)	68.16 (52.71)	73.97 (59.35)	74.22 (56.35)	76.85 (61.27)	77.98 (62.04)
Fenazaquin 10 SC	40 ml	17.2	47.57 (43.62)	46.32 (40.63)	54.90 (47.83)	55.88 (45.82)	77.73 (61.87)	73.67 (56.01)	80.94 (64.14)	77.35 (58.33)	82.63 (65.40)	83.67 (66.19)
Check	Water	15.34	13.39 (21.47)	16.08 (22.39)	15.61 (23.28)	15.10 (21.66)	17.01 (24.36)	18.04 (23.81)	17.84 (24.99)	20.34 (25.39)	19.96 (26.54)	20.95 (27.25)
C.D (p=0.05)	---	---	(7.65)	(6.07)	(6.30)	(4.62)	(8.17)	(3.33)	(6.98)	(4.85)	(2.45)	(2.54)

Each value is mean of three observations (includes Protonymph, deutonymph and adult mite)

Figures in parenthesis are Arc sin transformed values

Table 2. Bio-efficiency of Fenazaquin 20 EC against European red mite (*Panonychus ulmi*) on Red Delicious variety of apple at Government apple orchard, Chitkak (Handwara), Kupwara, during 2017-2018

Coded molecule	Concentration (Per 100 lit. of water)	Pre - treatment count	Percent mean mortality of <i>Panonychus ulmi</i>									
			Post count observation (DAT)									
			1 st		5 th		7 th		10 th		15 th	
			2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Fenazaquin 20 SC	15 ml	16.87	55.06 (47.92)	51.09 (45.64)	65.62 (54.12)	55.06 (47.92)	75.04 (60.05)	65.62 (54.12)	78.94 (62.71)	78.94 (62.71)	80.95 (64.15)	80.08 (63.52)
Fenazaquin 20 SC	20 ml	15.02	54.23 (47.44)	47.38 (43.51)	68.61 (55.95)	54.23 (47.44)	78.98 (62.74)	68.61 (55.95)	81.08 (64.24)	81.08 (64.24)	84.00 (66.45)	83.98 (66.43)
Fenazaquin 20 SC	25 ml	16.58	56.71 (48.88)	52.47 (46.43)	73.13 (58.80)	56.71 (48.88)	80.95 (64.15)	73.13 (58.80)	84.41 (66.77)	84.41 (66.77)	84.95 (67.20)	90.18 (71.77)
Hexythiazox 5.45 EC	40 ml	15.62	47.83 (43.77)	45.76 (42.58)	64.47 (53.43)	47.83 (43.77)	72.82 (58.60)	64.47 (53.43)	75.92 (60.64)	75.92 (60.64)	77.94 (62.01)	77.95 (62.02)
Fenazaquin 10 SC	40 ml	17.83	51.64 (45.96)	48.47 (44.14)	65.82 (54.24)	51.64 (45.96)	75.98 (60.68)	65.82 (54.24)	78.28 (62.25)	78.28 (62.25)	79.95 (63.43)	84.0 (66.45)
Check)Water spray)	Water	16.25	13.84 (21.85)	11.73 (20.03)	15.32 (23.05)	13.84 (21.85)	15.96 (23.55)	15.32 (23.05)	18.72 (25.64)	18.72 (25.64)	20.00 (26.57)	22.59 (28.39)
C.D (p=0.05)	-----	-----	(8.36)	(3.59)	(6.62)	(4.19)	(2.92)	(5.07)	(2.89)	(4.22)	(3.39)	(3.23)

Each value is mean of three observations (includes Protonymph, deutonymph and adult mite)
 Figures in parenthesis are Arc sin transformed values

Table 3. Bio-efficiency of Fenazaquin 20SC against European red mite (*Panonychus ulmi*) on Red Delicious variety of apple at Ferozpora, Rafiabab, Baramulla and Chitkak (Handwara), Kupwara Government apple orchard, (Two years pooled data for the year 2017 and 2018)

Code/ Chemical	Concentration (Per 100 lit. of water)	Percent Cumulative Mean Mortality of <i>Panonychus ulmi</i>					
		Ferozpora, Rafiabab, Baramulla			Government apple orchard, Chitkak (Handwara), Kupwara		
		2017	2018	Pooled	2017	2018	Pooled
Fenazaquin 20 SC	15 ml	65.09	63.85	64.47	71.12	66.15	68.35
Fenazaquin 20 SC	20 ml	71.46	70.47	70.95	73.38	67.05	70.21
Fenazaquin 20 SC	25 ml	75.06	72.33	73.69	76.05	71.38	73.71
Hexythiazox 5.45 EC	40 ml	62.77	63.11	62.94	67.79	62.38	65.08
Fenazaquin 10 SC	40 ml	68.75	67.38	68.06	70.33	65.64	67.98
Check)Water spray)	Water	16.76	18.10	17.43	16.76	16.44	16.60

Table 4. Toxicity of Fenazaquin 20EC against natural enemies of European Red Mite (*Panonychus ulmi*) on apple cv. Red Delicious at Ferozपुरa, Rafiabab, Baramulla, and Government orchard, Chitkak, Kupwara during the years 2017 and 2018 (Pooled)

Code/ Chemical	Concentration (Per 100 lit of water)	Coccinellids						Amblyseius					
		Ferozपुरa,Baramulla			Chitkak, Kupwara			Ferozपुरa,Baramulla			Chitkak, Kupwara		
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
Fenazaquin 20 SC	15ml	27.53	19.12	23.32	25.63	20.20	22.91	37.49	31.51	34.50	36.27	30.50	33.38
Fenazaquin 20 SC	20ml	32.09	22.20	27.14	28.73	23.91	26.32	39.96	35.54	37.75	38.57	32.70	35.63
Fenazaquin 20 SC	25ml	39.39	24.80	32.09	31.57	29.35	30.46	54.07	40.87	47.47	45.15	36.84	40.99
Hexythiazox5.45 EC	40ml	33.33	23.30	28.31	27.45	23.20	25.32	38.64	34.96	36.80	38.37	29.56	33.96
Fenazaquin 10 SC	40ml	34.67	23.31	28.99	29.14	22.68	25.91	41.04	37.13	39.08	41.78	32.50	37.14
Check)Water spray)	--	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Table 5. Effect of Fenazaquin 20 SC against European Red Mite (*Panonychus ulmi*) on yield (number of boxes) of apple variety cv. Red Delicious at Ferozपुरa, Rafiabab, Baramulla and Government orchard Chitkak, Kupwara during 2017 and 2018.

Treatment/ Chemical	Concentration (Per 100 lit of water)	Yield of A grade Apples/tree (Number of boxes per plant)					
		Ferozपुरa, Rafiabab, Baramulla			Government orchard Chitkak, Kupwara		
		2017	2018	Pooled	2017	2018	Pooled
Fenazaquin20 SC	15 ml	4.75	4.00	4.37	4.15	5.20	4.67
Fenazaquin20 SC	20 ml	5.40	4.85	5.12	4.75	5.35	5.05
Fenazaquin20 SC	25 ml	5.65	5.20	5.33	5.40	5.70	5.55
Hexythiazox5.45 EC	40 ml	5.10	4.40	4.75	4.35	5.40	4.87
Fenazaquin 10 SC	40 ml	4.40	4.32	4.36	4.0	4.75	4.37
Check)Water spray)	Water	2.00	2.40	2.20	2.45	2.65	2.55

SC at a dosage of 25 ml/100 L of water; which is closely followed by mite mortality of 87.25 and 83.95 per cent at recommended dose of 20 ml after 15 days of spray treatment during both the year, 2017 and 2018, respectively at location Ferozpora, Rafiabad, Baramulla.. The least ERM mortality of 82.63 and 83.67 per cent was recorded with standard check Hexythiozox 5.45 EC @ 40ml per 100 litres of water (Table 1).

In another location, Chitkak (Handwara), Kupwara; the maximum ERM mortality as 84.95 and 90.18 per cent was recorded with spray application of test molecule Fenazaquin 20 SC @ 25 ml/100 L of water during both the respective years. The standard check Hexythiozox 5.45 EC @ 0.40 ml per liter of water recorded least ERM mortality of 77.94 and 77.95 per cent after 15 days of spray application at both the respective locations as showed in (Table 2). Though, all the treatments were statistically significant from the control which registered mean mortality of ERM as 19.96 and 20.95 per cent at location. Ferozpora, Rafiabad, Baramulla; and 20.00 and 22.59 per cent at Chitkak (Handwara), Kupwara in both the respective years.

The natural enemies associated with *Panonychus ulmi* at both the locations were Coccinellids and predatory mite *Amblyseius* spp. during both the consecutive years of study. The least mortality of Coccinellids was 23.32 and 22.91 per cent with spray application of Fenazaquin 20 SC@15 ml/100 lit of water at both the location Ferozpora, Baramulla and Chitkak, Kupwara, respectively. However, molecule Fenazaquin 20 SC@ 25 ml was highly toxic to Coccinellids predators in recording highest mortality of 32.09 and 30.46 per cent at both the respective locations. Similarly, the minimum mortality of *Amblyseius* spp. as 34.50 and 33.38 per cent was recorded with treatment of Fenazaquin 20 SC @ 15 ml; whereas, the test molecule at dosage of 25 ml per 100 L of water recorded maximum mortalities of *Amblyseius* spp. at both the respective locations (Table 4). The test molecule Fenazaquin 20 SC at all the concentrations didn't cause any phytotoxicity during both the years at both the locations. The highest yield of apple fruit was computed with treatment application of test molecule Fenazaquin 20 SC @ 25 ml followed by the fruit yield obtained with test acaricide @ 20 ml per 100 litres of water as showed in (Table 4) [8].

The results are in consonance with the findings of Rana and Bhardwaj [9] who reported fenazaquin to be as highly effective and persistent against European red mite *Panonychus ulmi* on apple. The findings are more or less corroborated with the work of Reddy et al. [10] who compared the efficacy of fenazaquin, hexythiazox and other acaricides against *Tetranychus urticae* (Koch) both under laboratory and green house conditions. In laboratory conditions, fenazaquin and abamectin were observed giving 97-100% mortality, respectively; whereas, under, at greenhouse conditions, fenazaquin and abamectin gave cent per cent mortality. The higher toxicity of Fenazaquin20 SC observed during the study, receives support from Kim and Seo [11] who reported it to be very toxic to adult females and immatures of *Amblyseius womersleyi*. The moderate toxicity with standard check Hexythiazox5.45 EC received support from the findings of Hoy and Ouyang [12] who reported the acaricide to be safer against phytoseiid predator; whereas, moderate toxicity of standard check treatments corroborate the earlier reports of Croft [13] and Khajuria and Sharma [14].

4. CONCLUSION

The test molecule Fenazaquin 20 SC @ 25 ml per 100 litres of water recorded maximum ERM mortality of 90.45 and 87.99 per cent at location Ferozpora, Rafiabad; whereas, at another location Chitkak (Handwara), Kupwara, the highest ERM mortality was 84.95 and 90.18 per cent after fifteen days of spray application during both the respective years. The least mortality of natural enemies (Coccinellids) was recorded with the Fenazaquin 20 SC @ 15 ml per litre of water; whereas, the test molecule @ 25 ml registered highest Coccinellids mortality in both the locations.. The least mortality of *Amblyseius* spp. was observed with the test chemical @ 15 ml per litre of water.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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