Original Research Article

Bio-efficacy of Fenazaquin 20 SC against European red mite, *Panonychusulmi*(Acari: Tetranychidae) on apple in Kashmir

ABSTRACT

Efficacy studies were conducted during June-July in 2017 and 2018 at two locations in district Baramulla of Jammu and Kashmir against the phytophagousmite Panonychusulmi (Koch) in apple orchards. The test molecule Fenazaquin 20 SC at the dosages of 15, 20 and 25 ml along with standard checksHexythiazox 5.45 EC and Fenazaquin 10 SC at 40 ml per 100 litre of water was evaluated againstPanonychusulmi. 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 Ferozpura, 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, highestmortality of 32.09 and 30.46 was recorded with coded molecule @ 25 ml. in Ferozpura, Rafiabad; and Chitkak (Handwara), Kupwara. Similarly, the least mortality of Amlyseius spp. as 34.50 and 33.38 per cent was recorded with the chemical @ 15 ml per litre of water.The highest yield of appleswas recordedwith application of Fenazaquin 20 EC @ 25ml in both the locations.

Comment [y1]: Good work, but clearly state your recommendation, considering:
1. Efficacy, and its adverse effect on natural enemies.
2. Also, economic feasibility or you can leave this one for future work.

Key words: Apple, *Panonychusulmi*, Fenazaquin 20 SC, Hexythiazox 5.45 SC, efficacy, predators, safety

INTRODUCTION

Apple is considered as the an 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), *Quadraspidiotusperniciosus* and European red mite (ERM), *Panonychusulmi* 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 *Panonychusulmi* (Koch) and two spotted spider mite *Tetranychusurticae* (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. 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. In nature, phytophagous mites are kept under check by different predators such as predatory mites, *Chrysoperla* larvae, *Stethorus* beetles and predatory thripsetc.Khajuria and Sharma (1996) reported the phytoseiid mite *Amblyseiusfallacis* (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 (Overmeer, 1985).In recent past,indiscriminate use of insecticides has often been attributed for mite outbreaks.Though, numerousacaricides are being recommended for the effective mite management (Marshall and Pree, 1991; Khajuria*et al.*, 2006), butwith the passage of time many of these acaricideshave become obsolete either due to ban or their non-production. Besides, associated natural enemies are also adversely affected due to indiscriminatechemicals usage and exposure to manage phytophagousmites. Therefore, the newer acaricidesagainstphytophagous 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 litters of water was evaluated against phytophagousmites along with their safety to natural enemies in apple orchards.

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1. Bio-efficacy test for Fenazaquin, and
2. Their safety to safety to natural enemies

MATERIAL AND METHODS

The field trials were conducted at two different locations i.e. Government Apple orchard, Chitkak, (Handwara) Kupwara; and Ferozpura, 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 litters of water along with standard check Fenazaquin 10SC and Hexythiazox 5.45 EC each at 40 ml per 100 litres 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

Comment [y11]: I n this part include the following:
1.The formula used to calculate the corrected martalty percentage.
2.The software used to perform the analysis.
3.How the data was transformed.
4.Mention the author used for phytotoxicity scale
5.The life stages counted
6.Whether , mites count per 20 leaves were converted to per one leaf.
7.Whether other Agronomic and Pest Protection works were performed uniformly to all experimental units.
8.How the mites were counted, like
a.Using naked eyes or microscope
b.On field or laboratory
c. Form both sides of the leaves or one side
9. Whether homogeneity of variance was performed to combine the data over location or season/years.
10. The date when the treatments application started.

phytotoxicitydata on chlorosis, necrosis, wilting, scorching, hyponasty and epinasty were recorded after 1, 3,5,7, 10 and 15 days after spray using (1-10) scaleat 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.

RESULTS AND DISCUSSION

The highest mortality of European red mite (ERM) as90.45 and 87.99 per centwas recorded with the application of Fenazaquin 20 SCat a dosage of 25ml/100 lit 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 moleculeFenazaquin 20 SC@25 ml/100 lit of water during both the respective years. The standard check Hexythiozox 5.45 EC @ 0.40 ml per litre of water recorded least ERM mortality of 77.94 and 77.95 per cent after 15 days of spray application at both the respectivelocations (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 respectiveyears. The natural enemies associated with *Panonychusulmi*at both the locations wereCoccinellids and predatory mite *Amblyseius* sp.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 Coccinellidspredators in recording highest mortality of 32.09 and 30.46 per cent at both the respective locations. Similarly, the minimum mortality of *Amlyseius* 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 litre of water recorded maximum mortalities of *Amlyseius*spp at both the respective locations. (Table 4) The test molecule Fenazaquin 20 SC at all the concentrations doesn'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

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Comment [y13]: Not clear, these were not the treatments evaluated.

Comment [y14]: High yield does not necessarily mean economically feasible, so consider the cost of each treatment/dose.

Comment [y15]: Since it was highly toxic to natural enemies, its safety to them shall be under question mark. Hence, how are you going to recommend this dose to end users?

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@ 20 ml per 100 litres of water. The results are in consonance with the findings of Rana and Bhardwaj (2004) who reported fenazaquinto be as highly effective and persistent against European red mite *Panonychusulmi* on apple. The findings are more or less corroborated with thw work of Reddy*et al.* (2014) who compared the efficacy of fenazaquin, hexythiazoxand other acaricidesagainst *Tetranychusurticae* (Koch) both under laboratory and greenhouse conditions. In laboratory conditions, fenazaquin and abamectin were observed giving 97-100% mortality, respectively; whereas, under, at greenhouse conditions, fenazaquin and abamectingave cent per cent mortality.The higher toxicity of Fenazaquin20 SC observed during the study, receives support from Kim and Seo (2001) who reported it to be very toxic to adult females and immatures of *Amblyseiuswomersleyi*. The moderate toxicity with standard check Hexythiazox 5.45 EC received support from the findings of Hoy and Ouyang (1986) who reported the acaricide to be safer against phytoseiid predator; whereas, moderate toxicity of standard check treatments corroborate the earlier reports of Croft (1975) and Khajuria and Sharma (2010).

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CONCLUSION

Comment [y19]: Include "CONCLUSION"

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Comment [y20]: Use hanging style of referencing.

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Table 1: Bio-efficiency of Fenazaquin 20 SC againstEuropean red mite (*Panonychusulmi*) on Red Delicious variety of apple atFerozpura, Rafiabad, Baramulla, during 2017-2018

Coded molecule	Concentration (Per 100 lit. of water)	Pre -- treatment count	Percent mean mortality of *Panonychusulmi* Post count observation (DAT)									
			1st		5th		7th		10th		15th	
			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

Comment [y21]: Was that per 20 leaves or converted to per one leaf, clearly state that. This comment is for all tables.

Coded molecule	Concentration (Per 100 lit. of water)	Pre -- treatment count	Percent mean mortality of *Panonychusulmi* Post count observation (DAT)									
			1st		5th		7th		10th		15th	
			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)

Table 2: Bio-efficiency of Fenazaquin 20 ECagainst European red mite (*Panonychusulmi*) on Red Delicious variety of apple atGovernment apple orchard, Chitkak (Handwara), Kupwara, during 2017-2018

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 20SCagainst European red mite (*Panonychusulmi*) on Red Delicious variety of apple at Ferozpura, Rafiabad, BaramullaandChitkak (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 *Panonychusulmi*					
		Ferozpura, Rafiabad, 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 (*Panonychusulmi)* on apple cv. Red Delicious at Ferozpura, Rafiabad, Baramulla, and Government orchard, Chitkak , Kupwaraduring the years 2017 and 2018 (Pooled)

Code/ Chemical	Concentration (Per 100 lit of water)	Coccinellids						*Amblyseius*					
		Ferozpura,Baramulla			Chitkak, Kupwara			Ferozpura,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**
Hexythiazox 5.45 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 (*Panonychusulmi)* on yield (number of boxes) of apple variety cv. Red Delicious atFerozpura, Rafiabad, Baramulla and Government orchard Chitkak, Kupwaraduring 2017 and

Treatment/ Chemical	Concentration (Per 100 lit of water)	Yield of A grade Apples/tree (Number of boxes per plant)					
		Ferozpura, Rafiabad, Baramulla			Government orchard Chitkak, Kupwara		
		2017	2018	Pooled	2017	2018	Pooled
Fenazaquin 20 SC	**15 ml**	4.75	4.00	**4.37**	4.15	5.20	**4.67**
Fenazaquin 20 SC	**20 ml**	5.40	4.85	**5.12**	4.75	5.35	**5.05**
Fenazaquin 20 SC	**25 ml**	5.65	5.20	**5.33**	5.40	5.70	**5.55**
Hexythiazox 5.45 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**