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EFFICACY OF SOME ACARICIDES AGAINST ERIOPHYID MITE, *ACERIA* SP. (ACARINA: ERIOPHYIDAE) IN NORTH WEST HIMALAYAS

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ABSTRACT

Field experiments were conducted to evaluate efficacy of four acaricides namely dicofol 18.5EC (0.5 ml/L), propargite 57EC (0.2 ml/L), fenpyroximate 5EC (2.0 ml/L) and hexythiazox 5.45EC (1.8 ml/L) against eriophyid mite, *Aceria* sp. (Acarina: Eriophyidae) infesting seabuckthorn (*Hippophae* L.) in North West Himalayas. The results revealed that two sprays of these acaricides done at ten days interval reduced mite population by 98.8-99.4, 99.5-99.6, 96.1-99.3 and 84.1-99.5 per cent over pre-treatment as observed 10 days after second spray (DAS_2) in two years respectively. Whereas, mite population in control plants increased by 233.5-246.8 per cent over pre-treatment during the same time interval. Likewise, reductions in blister count on seabuckthorn leaves in two years varied from 63.2-78.6, 66.7-81.0, 68.8-70.0 and 56.3-70.0 per cent over pre-treatment as observed at $10DAS_2$ in case of dicofol 18.5EC (0.5 ml/L), propargite 57EC (0.2 ml/L), fenpyroximate 5EC (2.0 ml/L) and hexythiazox 5.45EC (1.8 ml/L) sprayed plants, respectively. While, leaves on the control plants registered 100-105.9 per cent increase in blister count during this same time. From present studies, it was concluded that the evaluated acaricides effectively checked the population build-up of eriophyid mite, prevented blister development and could be used for management of eriophyid menace on seabuckthorn.

INTRODUCTION

An eriophyid mite, *Aceria* sp. (Acarina: Eriophyidae) successfully thrives on seabuckthorn (*Hippophae* L.) (Sharma *et al.,* 2011) that exists over an area spanning approximately 12000 ha (Singh, 2003) in highlands of North West Himalayas. It is an immensely important but utterly underutilized plant that grows naturally in these high altitude regions and bears orange yellow berries in bunches. The real worth of this plant lies in rich treasure of industrially useful compounds found in its different parts. For instance, seabuckthorn berries have flavonols such as rutin, quercetin, myricetin, kaempferol, isorhamnetin (Hibasami *et al.,* 2005), tocopherols, tocotrienols (Kallio *et al.,* 2004; Luhua *et al.,* 2004) and carotenoids (Pintea *et al.,* 2001, Weller and Breithaupt, 2003) which possess antioxidant properties (Chaman *et al.,* 2011) and are useful in pharmaceutical formulations intended for improving the human immune system. Its seeds are rich in vitamin C, carotenoids, vitamin E, flavonoids, kaempferol, fatty acids, triacylglycerol, phytosterols, sugar, organic acids, proanthocyanidins and phenolic compounds (Abid *et al.,* 2007; Fan *et al.,* 2007; Li *et al.,* 2007). Besides this, bark and leaves of this plant also have many useful compounds such as flavonoids, carotenes, volatile oils, carbohydrates, vitamins, amino- and mineral acids that are important in pharmaceutical, nutraceutical and cosmetic industries (Catherine *et al.,* 2012; Sabir *et al.,* 2005; Wang *et al.,* 2011; Zeb, 2004a). Various other extracts of this plant also exhibit marked antioxidant activity (Chauhan *et al.,* 2007; Dhyani *et al.,* 2011; Geetha *et al.,* 2002; Negi *et al.,* 2005; Singh *et al.,* 2011; Suleyman *et al.,* 2002). The slender and worm like eriophyid mites possess piercing and sucking mouthparts which are used to extract plant nutrients and inject toxins that cause abnormal plant growth on many plant species of economic importance (Deinhart, 2011). The literature is replete with reports of pecuniary losses to agriculture, horticulture, forestry and plantation crops due to eriophyid infestations (Ashihara *et al.,* 2004; Debnath and Karmakar, 2013; Van Leeuwen *et al.,* 2010). Likewise, several earlier studies have reported susceptibility of eriophyid mites to a wide range of pesticides (Azevedo *et al.,* 2013; Isaacs *et al.,* 2004) and neem bio-pesticides (Badge *et al.,* 2014). However, studies on eriophyid mite injurious to seabuckthorn are utterly lacking. It is because of the fact that, hitherto, no eriophyid has ever been reported to infest this plant elsewhere. This microscopic mite observed on seabuckthorn caused leaves to become discolored and distorted due to blister development. These blisters dried out leaving behind dead areas on the leaf blade. Presence of multiple blisters on the single leaf due to severe mite infestation greatly reduced the photosynthetic area. Consequently, reduced photosynthetic activity weakened the plant resulting in poor berry production. Keeping in view the enormous industrial utility of this plant and concomitant threat to its scientific cultivation emanating from eriophyid menace, it was prudently thought to devise strategies for its management on seabuckthorn. Hence, the present manuscript deals with evaluation of some acaricides for the management of this eriophyid mite on seabuckthorn.

MATERIALS AND METHODS

Selection of seabuckthorn species for experimentation

Three species of seabuckthorn viz. *H. rhamnoides, H. salicifolia* and *H. tibetana* grow naturally in the North West Himalayan region including cold deserts of Lahaul and Spiti, Himachal Pradesh, India (Rousi, 1971; Zeb, 2004b). Of these, *H. rhamnoides* and *H. salicifolia* are more common and exist as natural stands throughout the two valleys. But, majority of these natural seabuckthorn stands are unmanaged, non-uniform and inaccessible. However, scientifically planned orchards of *H. rhamnoides* were established at a few locations in the Lahaul valley under National Agriculture Innovation Project (NAIP) funded by Indian Council of Agricultural Research (ICAR), New Delhi, India. These sites were easily accessible and had plants of uniform age required for scientific experimentation. Therefore, *H. rhamnoides* was selected for experimentation in the present studies.

Details of the experimental site

The present studies were carried out in village Trilokinath (Altitude: 3200 m amsl, Latitude: 32º40.699' N, Longitude: 76º41.928' E) in the Lahaul valley of Himachal Pradesh, India during summer 2011 and 2012. The selected site had terraced landform where *H. rhamnoides* orchard on about 0.5 ha was established in 2008. The plants were planted at spacing of 3 m within a row and two successive rows were spaced 5 m apart.

Selection of seabuckthorn plants for experimentation

Despite planting at the same time, uniformity lacked in the orchard which could be attributed to some differences in edaphic and agronomic factors inherent in the terraced land. Therefore, relatively uniform plants that measured around 1.5 to 2 m in height and showed symptoms of mite infestation were purposely chosen for assessing the efficacy of applied acaricides in managing eriophyid mite.

Tested acaricides and their doses

An identical dose (0.01%) of four acaricides namely dicofol 18.5EC (0.5 ml/L), propargite 57EC (0.2 ml/L), fenpyroximate 5EC (2.0 ml/L) and hexythiazox 5.45EC (1.8 ml/L) was tested against this blister inducing leaf mite. An unsprayed control was simultaneously maintained to compare the effectiveness of the applied acaricides.

Details of experimentation

The efficacy of acaricides was ascertained on the basis of the number of mites present in 2 mm wide leaf strip incised from center of the leaf specimen before and after application of acaricides as advocated by Pushpa (2006) for coconut perianth mite, *Aceria guerreronis* Keifer with minor modification. Three rows were selected at random from the orchard with each row representing single replication. Fifteen plants (3 plants/ treatment/replication) showing symptoms of eriophyid mite infestation as evidenced by presence of blistered leaves were selected. Three infested shoots per plant were aluminum tagged that indicated the applied acaricide. The whole plant along with tagged shoots was thoroughly sprayed with the test acaricide to prevent probable post spray colonization of leaves on the tagged shoots by mites moving from the unsprayed shoots. Selected acaricides were sprayed twice at ten days interval. Randomization in the acaricide application was achieved by ensuring that plants in the close proximity did not receive sprays of the same acaricide. Two leaves selected at random from each tagged shoot were collected 1 day before spraying (pre-treatment) and 3, 10 days after first and second spray (DAS_1/DAS_2). Thus, eighteen leaves collected from three plants sprayed with same acaricide constituted one replication. While collecting the leaves, care was taken not to hand touch the leaf lamina directly to ensure accuracy in microscopic observations on mite population. The leaves were held in hand from the pedicel, gently plucked and then packed in labeled plastic vials (12cm x 4cm) with perforated caps. Consequently, the vials were brought to the Plant Protection Laboratory of Highland Agricultural Research and Extension Centre, Kukumseri, Lahaul and Spiti of Himachal Pradesh Agricultural University, Palampur, India for recording data.

Data recording and statistical analysis

Data were recorded on the mite population and number of blisters on the leaves, formed as a result of feeding by eriophyid mite. Whereas, all blisters on the single leaf were visually counted, the mite population was microscopically determined by directly examining the leaf specimen under microscope as outlined by Monfreda *et al.* (2010). Care was also taken not to hand touch the leaf lamina while taking observations. For this purpose, single leaf was picked up and held in hand by forceps. Number of blisters on the picked leaf was noted and then a strip measuring 2 mm wide was incised with the help of a small sharp surgical scissor. The incised leaf strip was placed on the glass slide and examined under compound microscope (10X to 40X magnification) for recording mite population. The microscope too had slide adjustment mechanism for hands free observations. The minute and almost transparent moving mites were carefully counted from both sides by reversing the leaf strip with forceps. The data from all the eighteen leaves representing single replication were similarly recorded for all the three replications. The replication wise data were then aggregated and averaged separately to find mean blister count per leaf and mean mite count per 2 mm wide leaf strip for each replication. Subsequently, the data on blister and mite counts were statistically analyzed after square root transformation using CPCS1 software (Cheema and Singh, 1990). Afterwards, per cent change in mite count and blister count at 3, 10 DAS_1/ DAS_2 over pre-treatment were also worked out as below:

$$\text{Change in mite count (\%)} = \frac{(MC_n - MC_{ptm})}{MC_{ptm}} \times 100$$

Where, MC_n - mite count on n[th] day after acaricide application (n = 3, 10); MC_{ptm} - mite count at pre-treatment

$$\text{Change in blister count (\%)} = \frac{(BC_n - BC_{ptm})}{BC_{ptm}} \times 100$$

Where, BC_n - blister count on n[th] day after acaricide application (n = 3, 10); BC_{ptm} - blister count at pre-treatment.

The per cent changes in mite and blister counts were computed over pre-treatment instead of unsprayed control because changes in the same plants would be an ideal indicator of the efficacy of sprayed acaricides.

RESULTS

Effect of acaricides on population build-up of eriophyid mite

All the four acaricides evaluated against eriophyid mite infesting seabuckthorn effectively checked its spread and prevented blister development on the leaves. It was quite evident from the significant reduction in mite population (Table 1) and blister development (Table 2) on the leaves of sprayed plants as observed at 3 and 10 days after first (DAS_1) and second spray (DAS_2) over pre-treatment. On the other hand, significant increase in mite population and blister count over pre-treatment was observed on the leaves of unsprayed control plants during these times in both the years. At $3DAS_1$, maximum 93.8 and 88.9 per cent decrease in mite population over pre-treatment was recorded in plants sprayed with dicofol 18.5EC (0.5 ml/L) in 2011 and 2012, respectively. This corresponded to reduction in mite count from 83.6, 51.2 mites/2mm wide leaf strip at pre-treatment to 5.2, 5.7 mites/2mm wide leaf strip at $3DAS_1$ in two years, respectively. Whereas, the minimum reduction recorded in mite population at $3DAS_1$ over pre-treatment was 88.9 per cent in hexythiazox 5.45EC (1.8 ml/L) and 79.1 per cent in propargite 57EC (0.2 ml/L) sprayed plants in 2011 and 2012, respectively. The unsprayed control plants at this time recorded 28.4 and 50.7 per cent surge in mite population over pre-treatment in two years, respectively. Mite population in these unsprayed plants increased from 81.7, 45.4 mites/2mm wide leaf strip at pre-treatment to 104.9, 68.4 mites/2mm wide leaf strip at $3DAS_1$, in two respective years (Table 1). The per cent reduction in mite population over pre-treatment was lower at $10DAS_1$ when compared to $3DAS_1$. In the two years, the highest reduction in mite population over pre-treatment at $10DAS_1$ (76.9 %) was observed in hexythiazox 5.45EC (1.8 ml/L) sprayed plants during 2011. On the other hand, the lowest reduction in mite population over pre-treatment at $3DAS_1$ was 79.1 per cent in propargite 57EC (0.2 ml/L) sprayed plants during 2012. However, after the second spray of acaricides, mite population decreased and the maximum drop at $3DAS_2$ over pre-treatment (98.4, 98.7%) was recorded in fenpyroximate 5EC (2.0 ml/L) and minimum

Table 1: Effect of acaricides on population build-up of eriophyid mite (*Aceria* sp.) on leaves of seabuckthorn

Tested acaricides	Dose (ml/L)	Mean population of eriophyid mite (No./2mm wide leaf strip)[1,2,3]					Change in population of eriophyid mite over pre-treatment[4] (%)			
		PTM[5]	$3DAS_1$[6]	$10DAS_1$[6]	$3DAS_2$[6]	$10DAS_2$[6]	$3DAS_1$[6]	$10DAS_1$[6]	$3DAS_2$[6]	$10DAS_2$[6]
Dicofol 18.5EC	0.5	83.6 (9.2)	5.2 (2.5)[a]	26.0 (5.2)[ab]	3.5 (2.1)[a]	0.5 (1.2)[a]	-93.8	-68.9	-95.8	-99.4
		51.2 (7.2)[cd]	5.7 (2.6)[a]	22.4 (4.8)[a]	1.5 (1.6)[a]	0.6 (1.3)[a]	-88.9	-56.3	-97.1	-98.8
Propargite 57EC	0.2	89.8 (9.5)	8.9 (2.8)[a]	23.9 (5.0)[ab]	2.8 (1.9)[a]	0.4 (1.2)[a]	-90.1	-73.4	-96.9	-99.6
		39.7 (6.4)[b]	8.3 (3.0)[ab]	30.3 (5.6)[b]	1.5 (1.6)[a]	0.2 (1.1)[a]	-79.1	-23.7	-96.2	-99.5
Fenpyroximate 5EC	2.0	95.9 (9.8)	6.3 (2.7)[a]	32.0 (5.7)[ab]	1.5 (1.6)[a]	3.7 (1.9)[a]	-93.4	-66.6	-98.4	-96.1
		29.7 (5.5)[a]	5.7 (2.6)[a]	18.3 (4.4)[a]	0.4 (1.2)[a]	0.2 (1.1)[a]	-80.8	-38.4	-98.7	-99.3
Hexythiazox 5.45EC	1.8	93.7 (9.7)	10.4 (3.2)[a]	21.6 (4.7)[a]	7.4 (2.9)[b]	0.5 (1.2)[a]	-88.9	-76.9	-92.1	-99.5
		58.4 (7.7)[d]	10.5 (3.4)[b]	31.6 (5.7)[b]	6.9 (2.8)[b]	9.3 (3.2)[b]	-82.0	-45.9	-88.2	-84.1
Unsprayed control	-	81.7 (9.1)	104.9 (10.3)[b]	140.2 (11.9)[c]	198.3 (14.1)[c]	238.3 (15.5)[b]	+28.4	+71.6	+142.7	+246.8
		45.4 (6.8)[bc]	68.4 (8.3)[c]	90.6 (9.6)[c]	110.1 (10.5)[c]	151.4 (12.3)[c]	+50.7	+99.6	+142.5	+233.5
CD (0.05)		NS	(1.6)	(0.8)	(0.5)	(1.2)				
		(0.7)	(0.6)	(0.6)	(0.6)	(0.8)				

[1]Data in the first and second lines pertain to years 2011 and 2012, respectively; [2]Figures in the parentheses are square root transformed means; [3]Figures in the parentheses followed by the same alphabet are non-significant with each other; [4]Negative (-) and positive (+) signs denote decrease and increase in mite population, respectively; [5]Pre-treatment; [6]Days after first and second spray

Table 2: Effect of acaricides on development of blisters due to feeding by eriophyid mite (*Aceria* sp.) on leaves of seabuckthorn

Tested acaricides	Dose (ml/L)	Mean blister count (No./leaf)[1,2,3]					Change in blister count over pre-treatment[4] (%)			
		PTM[5]	$3DAS_1$[6]	$10DAS_1$[6]	$3DAS_2$[6]	$10DAS_2$[6]	$3DAS_1$[6]	$10DAS_1$[6]	$3DAS_2$[6]	$10DAS_2$[6]
Dicofol 18.5EC	0.5	1.9 (1.7)	1.8 (1.7)	1.5 (1.6)	1.3 (1.5)[a]	0.7 (1.3)[a]	-5.3	-21.1	-31.6	-63.2
		1.4 (1.5)	1.3 (1.5)	1.1 (1.4)[a]	0.6 (1.3)[a]	0.3 (1.1)[a]	-7.1	-21.4	-57.1	-78.6
Propargite 57EC	0.2	2.1 (1.8)	2.0 (1.7)	1.6 (1.6)	1.3 (1.5)[a]	0.4 (1.2)[a]	-4.8	-23.8	-38.1	-81.0
		1.5 (1.6)	1.4 (1.5)	1.1 (1.4)[a]	0.7 (1.3)[a]	0.5 (1.2)[a]	-6.7	-26.7	-53.3	-66.7
Fenpyroximate 5EC	2.0	2.0 (1.7)	1.8 (1.7)	1.6 (1.6)	1.0 (1.4)[a]	0.6 (1.3)[a]	-10.0	-20.0	-50.0	-70.0
		1.6 (1.6)	1.5 (1.6)	1.1 (1.4)[a]	0.5 (1.2)[a]	0.5 (1.2)[a]	-6.3	-31.3	-68.8	-68.8
Hexythiazox 5.45EC	1.8	2.0 (1.7)	1.8 (1.7)	1.6 (1.6)	1.2 (1.5)[a]	0.6 (1.3)[a]	-10.0	-20.0	-40.0	-70.0
		1.6 (1.6)	1.5 (1.6)	1.2 (1.5)[a]	0.6 (1.3)[a]	0.7 (1.3)[a]	-6.3	-25.0	-62.5	-56.3
Unsprayed control	-	1.7 (1.6)	1.8 (1.7)	1.9 (1.7)	2.6 (1.9)[b]	3.5 (2.1)[b]	+5.9	+11.8	+52.9	+105.9
		1.2 (1.5)	1.4 (1.6)	2.0 (1.7)[b]	2.1 (1.8)[b]	2.4 (1.8)[b]	+16.7	+66.7	+75.0	+100.0
CD (0.05)		NS	NS	NS	(0.1)	(0.2)				
		NS	NS	(0.1)	(0.2)	(0.2)				

[1]Data in the first and second lines pertain to years 2011 and 2012, respectively; [2]Figures in the parentheses are square root transformed means; [3]Figures in the parentheses followed by the same alphabet are non-significant with each other; [4]Negative (-) and positive (+) signs denote decrease and increase in blister count, respectively; [5]Pre-treatment; [6]Days after first and second spray.

(92.1, 88.2%) in hexythiazox 5.45EC (1.8 ml/L) sprayed plants in two years, respectively. The plants sprayed with fenpyroximate 5EC (2.0 ml/L) had only 1.5, 0.4 mites/2mm wide leaf strip at $3DAS_2$ as compared to 95.9, 29.7 mites/2mm wide leaf strip at pre-treatment in 2011 and 2012, respectively. The corresponding figures in plants sprayed with hexythiazox 5.45EC (1.8 ml/L) were 7.4, 6.9 mites/2mm wide leaf strip at $3DAS_2$ and 93.7, 58.4 mites/2mm wide leaf strip at pre-treatment in two years, respectively. At this time interval, mite population on unsprayed control plants increased by more than 142 per cent over pre-treatment in both the years. The respective mite count for two years in these unsprayed control plants was 198.3, 110.1 mites/2mm wide leaf strip at $3DAS_2$ as against 81.7, 45.4 mites/2mm wide leaf strip at pre-treatment (Table 1). At $10DAS_2$, all the acaricides recorded more than 96 per cent reduction in mite population over pre-treatment in both the years except hexythiazox 5.45EC (1.8 ml/L) sprayed plants in 2012 (84.1%). The mean mite count declined below 1.0 mite/2mm wide leaf strip in both the years except 9.3 mites/2mm wide leaf strip recorded in hexythiazox 5.45EC (1.8 ml/L) sprayed plants in 2012. Whereas, the control plant during this time recorded 246.8 and 233.5 per cent more mite population when compared to pre-treatment and it corresponded to 238.3, 151.4 mites/2mm wide leaf strip at $10DAS_2$ as compared to 81.7, 45.4 mites/2mm wide leaf strip at pre-treatment in respective years (Table 1).

Effect of acaricides on development of blisters on seabuckthorn leaves

In 2011, plants sprayed with evaluated acaricides reduced blister count on leaves by 20.0 to 23.8 per cent as recorded at $10DAS_1$ in comparison to pre-treatment although all were statistically non-significant to each other. However, 11.8 per cent increase in blister count over pre-treatment was observed in unsprayed control plants during the same time. The leaves of these plants recorded increase in the mean blister count from 1.7 blisters/leaf at pre-treatment to 1.9 blisters/leaf at $10DAS_1$. During 2012 also, tested acaricides did not differ significantly in reducing the blister count at $10DAS_1$. Nevertheless, the blister count on plants sprayed with acaricides varied from 1.1 to 1.6 blisters/leaf and was significantly lower than the unsprayed control plants which recorded 1.9, 2.0 blisters/leaf in two years, respectively. The highest reduction in blister count (31.3%) over pre-treatment during this time was recorded in those plants that were sprayed with fenpyroximate 5EC (2.0 ml/L) and the lowest (21.4%) in dicofol 18.5EC (0.5 ml/L) sprayed plants in this year. Correspondingly, the mean numbers of blisters per leaf decreased from 1.6, 1.4 at pre-treatment in respective acaricides to 1.1 at $10DAS_1$ in both the acaricides (Table 2). On the other hand, the control plants recorded 66.7 per cent increase in blister count over pre-treatment at this time in the same year which corresponded to 1.2 and 2.0 blisters/leaf at pre-treatment and $10DAS_1$, respectively. Similarly at 10 DAS_2, all the acaricides resulted in statistically similar reductions in blister count. However, the plants sprayed with propargite 57EC (0.2 ml/L) recorded the highest (81.0%) and dicofol 18.5EC (0.5 ml/L) the lowest (63.2%) reduction over pre-treatment in 2011. During 2012, dicofol 18.5EC (0.5 ml/L) sprayed plants again recorded the highest reduction in blister count over pre-treatment (78.6%) but the lowest (56.3%) was recorded in plants sprayed with hexythiazox 5.45EC (1.8 ml/L). Propargite 57EC (0.2 ml/L) sprayed plants during this year registered 66.7 per cent reduction in blister count over pre-treatment. On the other hand, blister count in the unsprayed control plants increased by 105.9 and 100 per cent over pre-treatment at $10DAS_2$ in 2011 and 2012, respectively. The mean blister count on these unsprayed plants increased from 1.7, 1.2 blisters/leaf at pre-treatment to 3.5, 2.4 blisters/leaf at $10DAS_2$ in two years, respectively (Table 2).

DISCUSSION

The eriophyid mite infestations on seabuckthorn have not yet been documented in the published literature. Whereas, wealth of literature exists on evaluation of numerous acaricides including dicofol 18.5EC, propargite 57EC, fenpyroximate 5EC and hexythiazox 5.45EC against many mites infesting various agriculture, horticulture and plantation crops. Therefore, the efficacy of acaricides used in present investigations has been discussed vis-à-vis earlier studies, albeit against mites including eriophyids damaging other crops. For instance, Kumar *et al.*, (2009) reported highest reduction (74.2%) in *Tetranychus urticae* Koch population on brinjal plants sprayed with dicofol 18.5EC (4.0 ml/L) followed by fenpyroximate 5EC (0.8 ml/L) (66.3%) and propargite 57EC (4.0 ml/L) (66.1%). On the other hand, Murthy and Bhushan (2010) found fenpyroximate 5EC (500-625 ml/ha) to be more effective in controlling eriophyid mite, *Aceria lycopersici* Solff on tomato and tetranychid mite, *Tetranychus cucurbitae* Rahman and Sapra on bottle gourd as compared to dicofol 18.5EC (1375 ml/ha). Reddy and Latha (2013) conducted field experiments to test the bio-efficacy of acaricides against two spotted spider mite, *T. urticae* on ridge gourd and found that hexythaizox 5.4EC (25 g a.i./ha) and fenpyroximate 5EC (30 g a.i./ha) were comparatively more efficacious and caused 66.5-70.6 and 69.9-82.8 per cent mite mortality at 14 days after spray (DAS) as compared to dicofol 18.5EC (250 g a.i./ha) (22.9-34.3%) and propargite 57EC (612 g a.i./ha) (36.3-55.6%). In the same way, Chakrabarti and Sarkar (2014) reported that fenpyroximate 5EC (60 g a.i./ha) and propargite 57EC (1000 g a.i./ha), each sprayed twice, gave 68.2 and 72.2 per cent control of *Polyphagotarsonemus latus* (Banks) infesting chilli. Likewise, Khajuria and Sharma (2010) reported moderate toxicity of propargite 57EC (0.057 %) against the two spotted spider mite and found it to be safer to the predatory mites. On the other hand, Kavya *et al.* (2015) concluded that fenpyroximate 5EC was more toxic to adult females of *T. urticae* with LC_{50} value of 1.91 ppm than dicofol 18.5EC (27.84 ppm) and propargite 57EC (31.73 ppm). A careful perusal of this literature would reveal that these acaricides had proven effective in managing eriophyid and tetranychid mites. Still, the variations in efficacy of same acaricide apparent in these studies could be attributed to varying doses and different target mite species besides diverse agro-ecological situations. However, the high efficacy of all these acaricides against eriophyid on seabuckthorn could be ascribed to its earlier non-exposure to any acaricide that probably made its populations highly susceptible to the applied acaricides. Villavicencio *et al.* (2014) found fenpyroximate 5EC effective for preventive and curative control of eriophyid mite, *Aceria aloinis* Keifer infesting aloe. These authors noted that ornamental aloe plants sprayed with fenpyroximate 5EC (16 fl oz/100 gallons water) had lower damage severity than the inoculated controls and no mites were found in the plants even one year after acaricide application. Their findings further revealed that curative control of infested plants was effective when plant tissue damaged by aloe mites was removed before acaricide application. Likewise, Koehler *et al.* (1987) observed that though dicofol 18.5EC (0.4 pounds a.i./100 gallons water) and propargite 57EC (0.3 pounds a.i./100 gallons water) suppressed fuchsia gall mite, *Aculops fuchsiae* Keifer, but the degree of suppression was insufficient for lasting control because of rapid mite reproduction. In the present studies too, though the applied acaricides suppressed the eriophyid mite population initially as observed at $3DAS_1$ but it increased slightly afterwards as revealed by lesser reductions over pre-treatment at $10DAS_1$ as compared to at $3DAS_1$. Nevertheless, the second spray of these acaricides effectively controlled the eriophyid mite as shown by reductions in its population (84.1-99.6%) and blister count (56.3-81.0%) on the leaves of seabuckthorn at $10DAS_2$. The efficacy of the acaricides could probably be improved if misshapen blistered leaves having colonies of eriophyid mites were removed prior to their application, as was observed by Villavicencio *et al.* (2014) in case of *A. aloinis* infesting ornamental aloe. This improved effectiveness of acaricides against *A. aloinis* could have resulted from lower mite inoculum subsequent to removal of shoots damaged by mites. However, manual removal of blistered seabuckthorn leaves would be practicable and justifiable only when these were few signifying low level of eriophyid infestation. Singh and Singh (2014) reported that fenpyroximate 5EC (1.0 ml/L), propargite 57EC (2.0 ml/L) and dicofol 18.5EC (2.5 ml/L) caused 81.3, 70.9 and 56.1 per cent mean mortality of tetranichid mite, *Tetranychus neocaledonicus* Andre infesting brinjal, respectively. The corresponding reductions in mite population over control were 79.1, 68.4 and 52.2 per cent, respectively. Similarly, the mean population of *T. urticae* infesting okra was reduced by 77.3, 71.9 and 66.9 per cent over control in plots sprayed with fenpyroximate 5EC (0.5 ml/L), propargite 57EC (2.0 ml/L) and dicofol 18.5EC (2.0 ml/L), respectively (Singh *et al.,* 2014). These studies lent support to present results where fenpyroximate 5EC (2.0 ml/L), propargite 57EC (0.2 ml/L) and dicofol 18.5EC (0.5 ml/L) caused significant eriophyid mortalities and reduced its population by 96.1, 99.6, 99.4 per cent over pre-treatment in 2011 and 99.3, 99.5, 98.8 per cent in 2012, respectively. Likewise, Reddy *et al.* (2014) also observed decrease in mortality of *T. urticae* on cucumber from 74.0, 81.3 per cent at 1DAS to 22.3, 39.2 per cent at 14DAS in dicofol 18.5EC (2.7 ml/L) and propargite 57EC (2.0 ml/L) sprayed plants, respectively. The corresponding mortalities recorded in fenpyroximate 5EC and hexythiazox 5.45EC both sprayed at the rate of 1.25 ml/L were 79.2, 83.9 per cent at 1DAS and 59.7, 55.7 per cent at 14DAS, respectively. The observations of these authors also corroborated the outcomes of present studies where reduction in eriophyid mite population decreased from 93.8, 90.1, 93.4, 88.9 per cent at $3DAS_1$ to 68.9, 73.4, 66.6, 76.9 per cent at $10DAS_1$ in 2011 and from 88.9, 79.1, 80.8, 82.0 per cent at $3DAS_1$ to 56.3, 23.7, 38.4, 45.9 per cent at $10DAS_1$ in 2012 in case of dicofol 18.5EC (0.5 ml/L), propargite 57EC (0.2 ml/L), fenpyroximate 5EC (2.0 ml/L) and hexythiazox 5.45EC (1.8 ml/L) sprayed plants, respectively. The increase in population a few days after first acaricide spray possibly occurred because of rapid multiplication due to short life cycle of the eriophyid mite. Present findings are also supported by Sood *et al.* (2015) who found dicofol 18.5EC (250 g a.i/ha) and propargite 57EC (430 g a.i/ha) effective against *T. urticae* on cucumber and observed reductions in its mean population from 13.7, 14.6 and 101.7, 111.3 mites/5 leaves at pre-treatment to 3.6, 3.9 and 1.6, 2.3 mites/5 leaves at 21 DAS_2 in autumn and summer crops, respectively grown under protected environment. Field bio-efficacy of fenpyroximate 5EC (15, 20, 25 g a.i./ha) and dicofol 18.5EC (250 g a.i./ha) against red spider mite, *Tetranychus cinnabarinus* (Boisd.) infesting brinjal showed that these acaricides effectively controlled this mite (Naik *et al.,* 2006) and both these acaricides were found quite effective in current investigations as well. However, the findings of Forti *et al.* (1994) suggested fenpyroximate 5EC to be very effective against tetranychid, *Panonychus ulmi* (Koch.) and comparatively less effective against the eriophyid *Aculus schlechtendali* (Nal.) infesting apple (cv-Golden Delicious) in Italy. Thus, their results were in contradiction to the present results where fenpyroximate 5EC (2.0 ml/L) conclusively proved highly effective against seabuckthorn eriophyid and caused more than 96 per cent reduction in mite population and around 70 per cent reduction in blister development on leaves at $10DAS_2$. The probable reasons for the lower efficacy of this acaricide against the eriophyid *A. schlechtendali* could be inherent differential susceptibility of the two species infesting different hosts. It could also be possible that the apple eriophyid had developed some level of resistance to the sprayed acaricide due to relatively heavy pesticides application usually resorted to in managed apple orchards. On the other hand, eriophyids on seabuckthorn were never subjected to pesticide pressure earlier and perhaps, therefore, comprised of highly susceptible population that readily succumbed to acaricide application. This inference invariably underscores the utility of rotational application of acaricides in management strategies against eriophyid mite menace. Moreover, some earlier studies had also indicated its comparative safety to natural enemies of mites. For instance, Lima *et al.* (2013) found fenpyroximate 5EC not only promising against coconut mite, *Aceria guerreronis* Keifer but also safer to its predator *Neoseiulus baraki* Athias-Henriot, as it recorded higher LC_{50} and LC_{90} values in laboratory studies. Similarly, Kim and Paik (1996) evaluated relative toxicity of fenpyroximate 5EC to kanzawa spider mite, *Tetranychus kanzawai* Kishida, an arthropod pest of tea and predatory mite, *Amblyseius womersleyi* Schicha under laboratory conditions and found it to be less toxic to adult females and eggs of *A. womersleyi* than *T. kanzawai*. They also reported no significant reduction in reproduction and hatchability of *A. womersleyi* eggs at concentrations of 6.25 to 50 ppm. Also, Bala *et al.* (2015) found very low population (1.4 mites/cm^2) of eriophyid mite, *Aceria tulipae* (Keifer) infesting garlic at 10DAS in dicofol 18.5EC (2.5 ml/L) sprayed plots and concluded that it was most effective acaricide against this eriophyid. Their studies also confirmed the results of present investigations where dicofol 18.5EC (0.5 ml/L) sprayed plants had just 3.5, 1.5 and 0.5, 0.6 mites/2mm wide leaf strip at $3DAS_2$ and $10DAS_2$ in two years, respectively.

In corollary, it could be concluded that evaluated acaricides effectively countered the population build-up of eriophyid mite on seabuckthorn. The blister formation on the leaves due to mite feeding was also substantially reduced in plants that received acaricide application. Hence, these acaricides could be used to manage eriophyid mite on seabuckthorn.

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