FIELD EVALUATION OF BIFENAZATE (ACRAMITE 50WP) FOR CONTROL OF TEA MITES

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ABSTRACT: Insects and mites are the most damaging of arthropod pests to tea (*Camellia sinensis* (L.) O. Kuntze) causing yield losses of 5–55%. Various mite species are associated with tea monocultures. In the Kangra valley, Himachal Pradesh, India red spider mites (*Oligonychus coffeae*) and scarlet mites (*Brevipalpus phoenicis*) are prevalent during June-July. For mite control, various conventional acaricides are used but resistance has developed to most of them. In India, few acaricides are recommended for controlling mites in tea. However, there are many new risk reduced selective acaricides which are reported to control mites effectively on crops other than tea. Two seasons field bioefficacy trials of bifenazate (Acramite 50WP) were conducted against red spider mites at different application rates (@ 100, 125, 175, 200, 250 g/ha) and results were compared with the propargite 57 EC (@1 l/ha). In season 1, a single spray of bifenazate @250 g/ha provided 63% control up to 35 days post treatment. Acramite @250, 200, 175, and 125 g/ha provided mite control which was not significantly different from each other. In season 2, a repeat spray was made on day 14 and treatments @250 and 200 g/ha provided 91–93% control up to 35 days. Treatments @ 175 and 125 g/ha provided 84–86% control similar to propargite @1 l/ha. In view of the per cent control of the population over a period of 35 days and depending on the situations, Acramite @200 or 125 g/ha with a follow up spray after 14 days is recommended for the control of tea mites.

KEY WORDS: Tea, *Camellia sinensis*, Insect pest, Mites, Bioefficacy, Field trials.

Tea, *Camellia sinensis* (L.) O. Kuntze (Family Theaceae) is one of the most important woody perennial plantation monoculture crops cultivated on large- and small-scale plantations. It is grown on over 2.71 million hectares in more than 34 countries to produce 3.22 million metric tons of tea annually (Hazarika et al., 2009). Tea is attacked by a large number of pests causing qualitative and quantitative losses. Globally, 1031 species of arthropods are reported to be associated with tea monoculture. Insects and mite pests are the most damaging, causing approximately US $500 million to $1 billion yield losses (Hazarika et al., 2009).

Mites, as a group, are persistent and are the most serious pests of tea plantations in almost all parts of the world. Amongst them, the red spider mite (RSM), *Oligonychus coffeae* is one of the most important arthropod pests of tea, widely distributed in India, Bangladesh, Sri Lanka, Taiwan, Burundi, Kenya, Malawi, Uganda, and Zimbabwe. RSM discovered in 1868 in Assam, India (Watt & Menn, 1903) is the most serious pest of tea in north-eastern and other parts of India (Roy et al., 2010). These mites live under a web cover and are found in economically damaging numbers from March to June but disappear with the monsoon rains. Moderate infestations may occur in September or October (Das, 1959). Nymphs and adults of red spider mites lacerate cells, producing minute characteristic reddish brown marks on the upper surface of mature leaves, which turn red in severe cases, resulting in crop losses.

In Himachal Pradesh, tea is mainly grown in the Kangra district in an area of 2348 hectares (Tea Board India, 2009) and *Oligonychus coffeae* is an important pest (Sharma, 2000; Shanker et al., 2002). For controlling mites, tea growers use conventional acaricides. Central Insecticides Board and Registration Committee, India has recommended only three miticides (Dicofol 18.5% E.C., Sulphur 40% SC and Sulphur 52% flowable, Fenazaquin 10 % EC) for the control of tea mites in India (Central Insecticides Board and Registration Committee, 2010). However, mites have developed resistance to all of these pesticides.

In recent years, a number of acaricides with novel or under-exploited modes of action have been introduced including bifenazate. It is an acaricidal hydrazine derivative, discovered in 1990 by Uniroyal Chemical and commercialized in 1999 by Crompton Corporation (Dekeyser & McDonald, 1994; Leeuwen et al., 2005). It is reported to have quick knockdown effects through contact activity and provides long residual control of a variety of mites (Dekeyser & McDonald, 1994; Dekeyser et al., 1994; Leeuwen et al., 2007; Ibtissem et al., 2009). It is labelled as a selective miticide for the control of a variety of mites on ornamentals and possesses low toxicity to mammals and aquatic life. Bifenazate is not persistent as it breaks down quickly in the environment; exerts rapid poisoning, and has no cross-resistance to many conventional acaricides (Dekeyser et al., 1996). Bifenazate is reported to be efficacious for controlling mites on various crops. The present study was conducted to generate bioefficacy data of this selective acaricide against tea mites in the Kanga valley.

MATERIALS AND METHODS

The acaricide, bifenazate (Acramite 50WP) was obtained from M/s Chemtura Chemicals India Pvt. Ltd., Mumbai. Its chemical formula is $C_{17}H_{20}N_2O_3$. The Propargite 57 EC was used as a positive control.

Experimental sites

Experiments were conducted during two seasons at Chauki Tea Garden, Palampur (Himachal Pradesh), India during 24 June-29 July 2008 and 5 June–10 July 2009. These tea gardens were selected after conducting periodic surveys for mite infestations in the region. Peak infestation was observed in June in both seasons at Chauki Tea Garden. Experiments were conducted following a randomized block design, with three plots per treatment. Each plot in the experiment was separated by two buffer rows of unsprayed tea. There were 25 tea bushes (100 x 65 cm space) per plot for each treatment including the untreated control. Infestation of mites varied from plot to plot. A pre-treatment count was taken in the respective plots to assess the distribution of mite population and plots were selected with almost uniform population distribution.

Treatment details and method of observation

There were seven treatments: five Acramite 50WP (bifenazate), one propargite, and one water sprayed control [T1 = bifenazate (Acramite 50WP) at 100 g/ha; T2 = bifenazate 125 g/ha; T3 = bifenazate 175 g/ ha; T4 = bifenazate 200 g/ha; T5 = bifenazate 250 g/ha; T6 = propargite 57 EC 1000 ml/ha; T7 = water spray (Control)]. Formulations were diluted in water for spraying. Tea bushes were sprayed using hand-operated knapsack sprayers of 15-l capacity at the rate of 500 l/ha. In the first season one spray was applied and observations were recorded for 35 days. In the second season, a second spray was applied after day 14 using the same rates.

Observations on mite population were made on both adaxial and abaxial sides of the seventy five (25 X 3) randomly collected mature leaves per 25 bushes (collected from the middle level of the tea bushes) in each plot for each treatment along with unsprayed control (Sarmah *et al.* 2009). The mites were counted on each leaf under a hand-held lens. Post-treatment observations were made for 35 days after each treatment on days 2, 4, 7, 14, 21, 28, and 35 (Tables 1 and 2). Observations were made phytotoxicity in the Acramite treatments on the basis of necrosis, epinasty, hyponasty, and leaf injury on tips and surface.

Statistical analysis

Reduction of the mite population was calculated from recorded observations for all the treatments and data were analyzed as per cent reduction in mite population over the control. Data obtained were statistically analyzed using SPSS (Release 7.5.1) for general linear model–general factorial-Duncan's multiple range test (α=0.05 and n=63).

RESULTS AND DISCUSSION

The bioefficacy results of the various treatments against *O. coffeae* are presented in Tables 1 and 2. Population precounts were 0–14 and 0–8 mites per leaf in seasons 1 and 2, respectively. The trial plots showed a mixed population of red spider and scarlet mites. However, scarlet mite numbers were very low and observations were made on *O. coffeae* only.

Season 1

On the second day after treatment, there was a 21 to 40% reduction in mite populations compared to the control in all the bifenazate treatments with a 38% reduction in the propargite treatment (Table 1). Maximum reduction (40%) was observed in the 250 g/ha bifenazate treatment which was significantly higher than the 100 g/ha (21%) and 125 g/ha (28%) treatments. However, reduction of mites obtained with the bifenazate treatments 250, 200 and 175 g/ha, and the propargite at 1 l/ha treatment were not significantly different. Reduced number of mites was observed in all treatments up to day 7, where 74–92% control was obtained in the bifenazate treatments comparable to propargite (90%). Maximum control was achieved with bifenazate at 200 g/ha (92%) which was significantly higher than bifenazate at 100 g/ha (74%) and 125 g/ha, (78%) but not significantly different from other treatments (Table 1). On day 14, reduction ranged from 69 to 92% in bifenazate treatments compared to 88% in the propargite treatment. From day 14 there was a progressive increase in mite populations until day 35. On day 35, population reductions ranged from 54–63% in bifenazate treatments with a 57% reduction in the propargite treatment. Differences for the various treatments were not statistically significant (Table 1).

Season 2

Bioefficacy results for season 2 are presented in Table 2. On day 2, reductions in mite numbers ranged from 20 to 44% in bifenazate treatments whereas propargite provided 34% control (Table 2). Maximum reduction (44%) occurred in bifenazate @ 250 g/ha, which with 200 g/ha was significantly higher than the rest of the treatments. The bioefficacy performance trend of the various treatments was similar to that observed in season 1. Continuous reduction in the mite population was noticed in all treatments up to day 7 (Table 2). A rise in the population was noticed 14 days after the treatment, and a second application of all treatments was made.

On day 21, reduction in mite numbers ranged from 76 to 93% in the bifenazate treatments comparable to propargite (88%). Maximum control was provided by bifenazate at 250 g/ha (93%), significantly greater than 100 g/ha (76%) and 125 g/ha (79%). On day 28, maximum control (92%) occurred in the 250 g/ha bifenazate, significantly greater than all treatments except 200 g/ha. On day 35, 250 g/ha bifenazate provided the best control (93%), significantly better than 100, 125, and 175 g/ha and the propargite treatments (Table 2). In both seasons none of the treatments showed visual signs of crop damage.

Bifenazate provided good control of tea mites for 14 days and re application on day 14 maintained control until day 35. Similar results were observed when Acramite was sprayed at 0.75 and 1.0 lb/acre (841 and 1121 g/ha) significantly lowering phytophagous mite densities in tart cherry for 2 weeks post-treatment (Alston, 2003). In pear, when Acramite 50 was applied at 1 lb/acre (1121 g/ha) it provided immediate reduction of two spotted mites to below the treatment threshold of 0.5–1.0 mites per leaf and control was achieved for over 40 days (VanBuskirk & Hilton, 2002). In other field trials of bifenazate conducted on pecan leaf scorch mite it was reported that 0.3 g bifenazate/l water was the lowest effective concentration. At this rate, the effective residual activity was 2–6 weeks depending on the year and location when applied at 1400 l/ha (Dutcher et al., 2009).

In our study mite reduction may have been due to the direct contact of bifenazate on mites or through contact with foliar residues (FAO, 2006). Bifenazate applied @200 and 250 g/ha provided significantly better control than propargite 1l/ha. This may be due to the unique mode of action with excellent knockdown activity and susceptibility of the mites to bifenazate. Currently, there are no reports of cross-resistance to bifenazate in mites resistant to older conventional acaricides (Grosscurt & Avella, 2005; Leeuwen et al., 2005; Ochiai et al., 2007).

Bifenazate has been reported to be a selective acaricide (James, 2002) and is commercialised for the control of economically important phytophageous mite species including *Tetranychus* spp., *Panonychus* spp. and *Oligonychus* spp. (Dekeyser et al., 1996; Leeuwen et al., 2005; Pree et al., 2005). Based on this study, it can be concluded that bifenazate will provide effective control of tea mites. It is reported to show limited toxicity to beneficial insects and mites at the recommended application rates (James & Coyle, 2001; Grosscurt & Avella, 2005) and is reported not to adversely affect predatory mites under laboratory and field studies (Kim & Seo, 2001; Dutcher et al., 2009). Due to its low mammalian toxicity (50% lethal dose 5000 mg/kg) and environmental persistence (50% degradation time <1 day) (Dekeyser, 2005), it is suitable for application in tea crops for mite control. Moreover, the National Drugs and Poisons Schedule Committee has recommended that bifenazate be exempted from requirements of scheduling in the Standard for the Uniform Scheduling of Drugs and Poison. The Australian Pesticides and Veterinary Medicines Authority is satisfied that the proposed importation and use of bifenazate would not be an undue toxicological hazard to the safety of people exposed to it during its handling and use (Commonwealth of Australia Gazette no. APVMA 5, 6 May 2003).

However, care should be taken with application of bifenazate with other pesticides as it is reported that organophosphates and carbamates interfere with bifenazate efficacy, most probably by inhibiting carboxylesterases responsible for the activation of the pro-drug. As a result of the strong antagonism, mixtures of bifenazate with carbamates or organophosphates should not be used under field conditions (Leeuwen et al., 2007).

Our data on this selective acaricide and other reports suggest bifenazate may be a useful land effective acaricide included in the integrated pest management of tea mites. Application of bifenazate at 125-200 g/ha with a follow up application after 14 day is recommended and should provide good control for at least 35 days.

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Table 1. Bioefficacy of different treatments of bifenazate 50WP against tea mites (Season 1: June-July, 2008).

Treatments Bifenazate 50WP	% Reduction in mite population over control (Mean±S.D.) (Days after treatment)						
	2	4	7	14	21	28	35
T1: 100 g/ ha	21.42±3.65c	49.39±5.17d	73.86±5.00c	69.47±4.08c	64.14±4.63d	61.15±4.91c	53.83±4.35b
T2: 125 g/ ha	28.05±5.10b	60.16±3.72c	78.46±5.3b	83.04±6.16b	74.66±4.62c	62.26±6.13c	57.09±6.56ab
T3: 175 g/ ha	36.09±4.32a	75.21±4.90b	88.52±3.54a	89.80±3.59a	83.94±4.57ab	65.84±4.53bc	57.74±6.88ab
T4: 200 g/ ha	34.28±6.17a	77.24±5.85ab	91.88±3.00a	88.66±4.24a	86.15±6.06ab	70.80±5.32ab	61.63±4.50a
T5: 250 g/ ha	40.34±5.95a	78.33±8.29ab	91.53±5.26a	91.76±3.89a	87.81±4.38a	75.82±6.88a	62.79±6.67a
T6: Propargite 57 EC @1000 ml/ha	37.88±8.82a	81.85±6.22a	89.53±5.52a	88.00±5.11a	81.49±6.90b	70.39±3.91b	57.47±3.85ab

Data values in the column represented by the common letters are not statistically significant (General factorial-DMRT).

Table 2. Bioefficacy of different treatments of bifenazate 50WP against tea mites (Season 2: June-July 2009).

Treatments Bifenazate 50WP	% Reduction in mite population over control (Mean±S.D.) (Days after treatment)						
	2	4	7	14^{2}	21	28	35
T1: 100 g/ ha	20.16±2.59c	42.10±5.23d	71.30±6.78b	70.40±6.68b	75.89±8.33b	78.91±6.69d	76.71±5.08c
T2: 125 g/ ha	29.85±3.28b	54.16±5.69c	75.06±7.38b	74.84±9.68b	79.36±6.34b	82.29±4.78cd	84.15±4.48b
T3: 175 g/ ha	33.17±5.98b	72.55±5.36b	86.67±3.61a	87.59±4.74a	88.45±3.40a	85.46±2.75bc	86.47±3.96b
T4: 200 g/ ha	39.99±4.83a	75.05±6.35ab	85.77±5.54a	88.21±3.99a	90.48±4.43a	88.00±2.19ab	90.67±4.79a
T5: 250 g/ ha	44.40±8.04a	80.05±6.18a	88.62±5.36a	91.17±2.87a	93.32±3.09a	91.65±2.40a	92.67±2.79a
T6: Propargite 57 EC @1000 ml/ha	34.10±6.72b	74.79±4.83ab	87.72±3.43a	85.37±3.52a	88.54±3.64a	83.90±3.02c	84.04±2.99b

Data values in the column represented by the common letters are not statistically significant (General factorial-DMRT).