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Field bio-efficacy of novel combination insecticide on sucking pests of cotton

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Abstract
Field evaluation was carried out to determine the bio-efficacy of newer combination insecticide against major sucking pests in cotton, a field study was undertaken at College of Agriculture, Raichur, University of Agricultural Sciences, Raichur during 2022-23. Totally two sprays were under taken at different intervals by using six different insecticides. Population of whiteflies and mites were observed at pre and three, seven and fourteen days after each spray. In both the sprays evidenced the superiority of Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 g a.i./ha by recording least number of whiteflies (2.77/3 leaves) and mites (1.92/cm. sq) population at fourteen days after second spray with percent reduction over control of 75.05 and 89.80 respectively followed by next lower dosage treatments and standard checks. Among the treatments, highest seed cotton yield of 26.52 q/ha was recorded in the highest dosage of Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 g a.i./ha and was on par with Fenazaquin 10 EC + Bifenthrin 4 EC @ 125 + 50 g a.i./ha recorded 25.72 q/ha. Percent increase in yield over control in the treatment Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 g a.i./ha was 35.71.

Keywords: Bioefficacy, cotton, mites, resistance management, whiteflies

Introduction
Cotton, which is grown in more than 70 countries and has a huge potential to create jobs in both rural and urban areas, is widely recognized as one of the most significant commercial cash and fiber crops in the world. Cotton, commonly referred to as "White Gold" in India, is essential to the nation's agricultural environment. It can flourish in a variety of agroclimatic conditions and is the main source of raw materials for the textile industry, fulfilling almost two-thirds of its needs. Main losses in cotton production are due to its susceptibility to about 162 species of insect pests and a number of diseases (Dhaliwal and Arora, 1998) among which Low productivity in cotton is attributed to the most serious one is the intensity of insect pests attack (Manjunath, 2004) [8]. Cotton production has grown, bollworm losses have decreased, and insecticide use has decreased since Bollgard technology was introduced in 2002. Nevertheless, these modifications have made it possible for other pests to endure and become economic pests (Rao and Dev, 2009) [10].

Beyond India's boundaries, cotton is grown in more than 70 nations in tropical and subtropical climates. Key producers include China, the USA, India, Pakistan, and several others (Steven *et al.*, 2008) [11]. Despite its economic importance, cotton cultivation grapples with production difficulties, compounded by the pervasive threat of insect pests. Although transgenic cotton shows promise in the fight against bollworms (Kulkarni *et al.*, 2003) [7], the problem of sucking pests sucking pests *viz.*, aphids, leafhoppers, whiteflies, thrips and mites have emerged as formidable adversaries, causing substantial damage at various growth stages and ultimately diminishing crop yield (Ban *et al.*, 2010) [3].

Even the adoption of Bt-cotton, with its inherent advantages, does not shield against production losses inflicted by sap-feeding pests such leafhoppers, aphids, thrips, whiteflies, and mealy bugs during the growth season (Biradar and Venilla, 2008) [4]. Leaf yellowing, wrinkles, and distortion are typical symptoms caused by a large infestation of sucking insect nymphs and adults. They also exude honey dew which contributes to the formation and development of sooty-mould fungus (*Capnodium* sp.) on leaves. The fungus reduces the photosynthetic activity of the plants resulting in chlorosis that affects the seed cotton yield.

Moreover, whitefly also acts as a vector to transmit leaf curl disease in cotton. In order to boost production, insecticides are employed in pest management to maintain insect numbers below the ETL in better and faster successions. Insecticide resistance management also plays a key role in delaying the resistance build-up in the particular pest, instead of sole insecticide molecules combination insecticides plays a key role in resistance delaying. Therefore, with a view to find efficacy of new novel insecticide combination, this experiment has been conducted for management of sucking pests in cotton.

Materials and Methods

Field experiment was conducted at Entomology block, College of Agriculture, Raichur. The experiment was laid out in Randomized Block Design (RBD) with six treatments (Fenazaquin 10 EC + Bifenthrin 4 EC at three different doses @ 100 + 40; 125 + 50 and 156.5 + 62.6, Bifenthrin 10% EC @ 80, Spiromesifen 22.90% SC @ 144 g.ai/ha along with the untreated control) and four replications. The Bt-cotton hybrid "Jadoo (KCH-14K59)" with a spacing 90 cm between rows and60 cm between plants was sown and crop was raised as per recommended agronomical practices. Treatments were imposed as and when any one of the major sucking pests *viz.*, whitefly and mites crossed economic threshold level (ETL). Totally, two sprays were given at 15days interval for each treatment. The observation on the whiteflies per three leaves were recorded from top three fully formed leaves per plant in 10 randomly selected plants of each treatment a day before spray and after spray *viz.*, 3, 7 and 14 days after spray (DAS). Observation on the mites count on top three leaves from 10 randomly selected plants (In 1 sq cm area in each leaf) was recorded. However, reduction of pest population and increase in the yield over control was calculated using the formula given below.

$$\text{Reduction over control (\%)} = \frac{\text{No of insects in control-No of insects in treatment}}{\text{No of insects in control}} \times 100$$

$$\text{Yield increase over control (\%)} = \frac{\text{Yield in treated plot-Yield in control plot}}{\text{Yield in treated plot}} \times 100$$

The data obtained in the experiments under current investigation for whitefly per three leaves and mites were subjected to ANOVA for a randomized complete block design with suitable statistical transformation (arc sine and square root) in XLSTAT open source software.

Results and Discussion

Bio-efficacy of Fenazaquin 10 EC + Bifenthrin 4 EC against whiteflies

A day before spray the population of whiteflies ranged from 10.30 to 11.39 adults per three leaves and there was no significant difference among the treatments. Three days after spray, among the different chemical treatments Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 ga.i./ha recorded minimum of 2.17adults per three leaves which was significantly superior and on par with treatment Fenazaquin 10 EC + Bifenthrin 4 EC @ 125 + 50 g a.i./h (2.41 adults/3 leaves). The treatments Spiromesifen 22.90% SC @ 144 g a.i./ha, Fenazaquin 10 EC + Bifenthrin 4 EC @ 100 + 40 g a.i./ha and Bifenthrin 10% EC @ 80 g a.i./ha recorded 5.17, 5.17 and 5.27 adults per three leaves. The untreated control recorded 12.22 adults per three leaves. Similar trend was noticed at seven days after spray where the lowest population whiteflies was recorded in the highest dose treatment of Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 a.i./ha (0.47/three leaves) followed by its next lower dosage treatment Fenazaquin 10 EC + Bifenthrin 4 EC @ 125 + 50 a.i./ha (0.78/3 leaves) (Table 1).

During second spray (Table 2) whiteflies ranged from 10.61 to 11.61 adults per three leaves and there was no significant difference among the treatments. Three days after spray, among the different chemical treatments Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 a.i./ha recorded minimum of 1.23 adults per three leaves which was significantly superior and on par with treatment Fenazaquin 10 EC + Bifenthrin 4 EC @ 125 + 50 g a.i./h (1.58 adults/3 leaves). The treatments Spiromesifen 22.90% SC @ 144 g a.i./ha, Fenazaquin 10 EC + Bifenthrin 4 EC @ 100 + 40 g a.i./ha and Bifenthrin 10% EC @ 80 g a.i./ha recorded 3.95, 4.17 and 4.27 adults per three leaves. At seven and fourteen days after second spray Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 a.i./ha maintained its superiority in reducing the whiteflies population. Field experiments on cotton revealed that the higher dose ofbifenthrin 10 EC (1000 ml/ha) recorded 81.56 percent reduction from control in whiteflies, and it was on par with bifenthrin 10 EC (800 ml/ha), that recorded 79.01 percent reduction from control for whiteflies (Balakrishnan *et al.*, 2009) [2]. Similarly the field experiment conducted on tomato whitefly revealed that Fenazaquin 10 EC + Bifenthrin 4 EC @ 1.75, 1.50 & 1.25 ml/l recorded the whiteflies population range from 1.43 to 1.83 per plant and were found to be lowest compared to the standard check treatments (Mahendra and Singh, 2022; Kotak *et al.*, 2022) [9, 6].

Bio-efficacy of Fenazaquin 10 EC + Bifenthrin 4 EC against mites

A day before spray the population of mites ranged from 16.43 to 17.45 mites per three leaves and there was no significant difference among the treatments. Three days after spray among the different chemical treatments, Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 a.i./ha was found to be superior and recorded minimum of 3.50 mites per three leaves was on par with Fenazaquin 10 EC + Bifenthrin 4 EC @ 125 + 50 g a.i./ha (3.81 mites/3 leaves). Further, the Fenazaquin 10 EC + Bifenthrin 4 EC @ 100 + 40 g a.i./ha and Spiromesifen 22.90% SC @ 144 g a.i./ha were on par with each other recorded the mite population of 6.60 and 6.71 mites per three leaves. The treatment Bifenthrin 10% EC @ 80 g a.i./ha recorded population 18.38 mites per three leaves. The untreated control recorded 18.58 mites per three leaves. At seven days after spray the treatment Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 a.i./ha recorded lowest population of 0.57 mites per three leaves was on par with the next best treatment Fenazaquin 10 EC + Bifenthrin 4 EC @ 125 + 50 g a.i./ha recorded 0.77 mites per three leaves (Table 3 & 4).

The treatment Spiromesifen 22.90% SC @ 144 g a.i./ha and Fenazaquin 10 EC + Bifenthrin 4 EC @ 100 + 40 a.i./ha and recorded 3.09 and 3.23 mite population per three leaves. Highest population was recorded in treatment Bifenthrin 10% EC @ 80 g a.i./ha (20.95 mites/three leaves). The untreated control recorded 21.17 mites per three leaves. After second spray lowest population of mites were recorded in the highest dose of Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 a.i./haat three, seven and

fourteen days after spray and percent reduction over control was observed to be 82.50. Sa magnitude (fenazaquin 10% + bifenthrin 4%) is unique combination of chemicals for effective and long duration control of red spider mite, white fly and mosquito bug. It has both contact and stomach actions. It is a very effective insecticide used as foliar spray (Anon., 2022) [1].

Seed cotton yield

Maximum seed cotton yield of 26.52 q/ha was recorded in the highest dosage of Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 g a.i./ha and was on par with Fenazaquin 10 EC + Bifenthrin 4 EC @ 125 + 50 g a.i./ha recorded 25.72 q/ha. This was followed by next lower dosages of Fenazaquin 10 EC + Bifenthrin 4 EC @ 100 + 40 g a.i./ha, Spiromesifen 22.90% SC @ 144 g a.i./ha recorded 23.31and 22.94q/ha and were on par with eachother. Untreated control recorded lowest 17.05 q/ha seed cotton yield. Percent increase of yield over control was also calculated and the treatment Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 g a.i./ha was 37.5 percent over control followed by its next lower dosage treatment (Table 5). The moderate to high yield of tomato fruit was obtained from different concentration of Fenazaquin 10 EC + Bifenthrin 4 EC @ 1.75ml/lit, 1.50 ml/lit and 1.25 ml/lit gave tomato yield of 76.67, 70.00 and 66.67 q/ha, respectively (Mahendra and Singh, 2022, Kotak *et al.*, 2022) [9, 6].

Table 1: Bio-efficacy of Fenazaquin 10 EC + Bifenthrin 4 EC against whiteflies on cotton during *kharif* 2022-23 after 1st Spray

Sl. No	Treatments	Dosage (g.ai/ha)	Whiteflies/3 leaves					
			DBS	3DAS	7DAS	14DAS	Mean	% Reduction over control
1	Fenazaquin 10 EC + Bifenthrin 4 EC	100 + 40	10.82 (3.36)	5.17 (2.38)	3.16 (1.91)	8.35 (2.97)	5.56	56.60
2	Fenazaquin 10 EC + Bifenthrin 4 EC	125 + 50	10.30 (3.29)	2.41 (1.71)	0.78 (1.13)	7.83 (2.89)	3.67	71.32
3	Fenazaquin 10 EC + Bifenthrin 4 EC	156.5 + 62.6	11.39 (3.45)	2.17 (1.63)	0.47 (0.98)	6.95 (2.73)	3.20	75.05
4	Bifenthrin 10% EC	80	10.80 (3.36)	5.27 (2.40)	3.41 (1.98)	8.31 (2.97)	5.66	55.79
5	Spiromesifen 22.90% SC	144	10.39 (3.30)	5.17 (2.38)	3.28 (1.94)	7.93 (2.90)	5.46	57.37
6	Untreated Control	--	11.20 (3.42)	12.22 (3.57)	12.93 (3.66)	13.27 (3.71)	12.81	0.00
SEm ±			0.44	0.04	0.06	0.08		
CD at 5%			NS	0.12	0.16	0.24		

DBS: Days Before Spray DAS: Days After Spray

***** Figures in parentheses are square root transformed values

Table 2: Bio-efficacy of Fenazaquin 10 EC + Bifenthrin 4 EC against whiteflies on cotton during *kharif* 2022-23 after 2nd Spray

Sl. No	Treatments	Dosage (g.ai/ha)	Whiteflies/3 leaves					
			DBS	3DAS	7DAS	14DAS	Mean	% Reduction over control
1	Fenazaquin 10 EC + Bifenthrin 4 EC	100 + 40	11.04 (3.40)	4.27 (2.18)	1.92 (1.56)	7.76 (2.87)	4.65	62.10
2	Fenazaquin 10 EC + Bifenthrin 4 EC	125 + 50	10.52 (3.32)	1.58 (1.44)	0.93 (1.20)	7.24 (2.78)	3.25	73.51
3	Fenazaquin 10 EC + Bifenthrin 4 EC	156.5 + 62.6	11.42 (3.45)	1.23 (1.32)	0.72 (1.10)	6.36 (2.62)	2.77	77.42
4	Bifenthrin 10% EC	80	10.61 (3.33)	4.37 (2.21)	2.17 (1.63)	7.72 (2.87)	4.75	61.26
5	Spiromesifen 22.90% SC	144	11.02 (3.39)	3.95 (2.11)	2.04 (1.59)	7.34 (2.80)	4.44	63.79
6	Untreated Control	--	11.61 (3.48)	12.18 (3.56)	12.80 (3.65)	11.83 (3.51)	12.27	0.00
SEm ±			0.33	0.04	0.05	0.07		
CD at 5%			NS	0.12	0.14	0.21		

DBS: Days Before Spray DAS: Days After Spray

***** Figures in parentheses are square root transformed values

Table 3: Bio-efficacy of Fenazaquin 10 EC + Bifenthrin 4 EC against mites on cotton during*kharif* 2022-23 after 1st Spray

Sl. No	Treatments	Dosage (g.ai/ha)	Mites/cm.sq					
			DBS	3DAS	7DAS	14DAS	Mean	% Reduction over control
1	Fenazaquin 10 EC + Bifenthrin 4 EC	100 + 40	16.88 (4.17)	6.60 (2.66)	3.23 (1.93)	9.02 (3.09)	6.28	69.63
2	Fenazaquin 10 EC + Bifenthrin 4 EC	125 + 50	16.36 (4.11)	3.81 (2.08)	0.77 (1.13)	7.23 (2.78)	3.94	80.97
3	Fenazaquin 10 EC + Bifenthrin 4 EC	156.5 + 62.6	16.86 (4.17)	3.50 (2.00)	0.57 (1.03)	6.79 (2.70)	3.62	82.50
4	Bifenthrin 10% EC	80	17.45 (4.24)	18.38 (4.35)	20.95 (4.63)	22.22 (4.77)	20.52	0.84
5	Spiromesifen 22.90% SC	144	17.26 (4.21)	6.71 (2.69)	3.09 (1.89)	8.88 (3.06)	6.23	69.91
6	Untreated Control		16.43 (4.11)	18.58 (4.37)	21.17 (4.66)	22.33 (4.78)	20.69	0.00
S.Em ±			0.47	0.03	0.03	0.05		
CD at 5%			NS	0.10	0.10	0.17		

DBS: Days Before Spray DAS: Days After Spray
***** Figures in parentheses are square root transformed values

Table 4: Bio-efficacy of Fenazaquin 10 EC + Bifenthrin 4 EC against mites on cotton during*kharif* 2022-23 after 2nd Spray

Sl. No	Treatments	Dosage (g.ai/ha)	Mites/cm.sq					
			DBS	3DAS	7DAS	14DAS	Mean	% Reduction over control
1	Fenazaquin 10 EC + Bifenthrin 4 EC	100 + 40	12.33 (3.58)	3.92 (2.10)	2.78 (1.81)	6.58 (2.66)	4.43	76.45
2	Fenazaquin 10 EC + Bifenthrin 4 EC	125 + 50	11.81 (3.51)	1.03 (1.24)	0.68 (1.09)	4.53 (2.24)	2.08	88.94
3	Fenazaquin 10 EC + Bifenthrin 4 EC	156.5 + 62.6	12.31 (3.58)	0.83 (1.15)	0.57 (1.03)	4.35 (2.20)	1.92	89.80
4	Bifenthrin 10% EC	80	15.17 (3.96)	15.68 (4.02)	20.08 (4.54)	19.78 (4.50)	18.51	1.52
5	Spiromesifen 22.90% SC	144	12.71 (3.63)	4.05 (2.13)	1.84 (1.53)	6.44 (2.63)	4.11	78.14
6	Untreated Control	--	16.14 (4.08)	17.58 (4.25)	18.92 (4.41)	19.89 (4.52)	18.80	0.00
S.Em ±			0.46	0.06	0.05	0.15		
CD at 5%			NS	0.17	0.13	0.42		

DBS: Days Before Spray DAS: Days After Spray
***** Figures in parentheses are square root transformed values

Table 5: Efficacy of Fenazaquin 10 EC + Bifenthrin 4 EC on cotton yield during *kharif*, 2022-23

Sl. No	Treatments	Dose: g a.i/ha	Yield (q/ac)	Increase over control (%)
1	Fenazaquin 10 EC + Bifenthrin 4 EC	100 + 40	23.31	26.85
2	Fenazaquin 10 EC + Bifenthrin 4 EC	125 + 50	25.72	33.70
3	Fenazaquin 10 EC + Bifenthrin 4 EC	156.5 + 62.6	26.52	35.71
4	Bifenthrin 10% EC	80	22.67	24.79
5	Spiromesifen 22.90% SC	144	22.94	25.67
6	Untreated control	---	17.05	0.00
S.Em ±			0.51	
CD at 5%			1.53	

Conclusion

Fenazaquin 10 EC + Bifenthrin 4 EC @ 156.5 + 62.6 and 125 + 50 g a.i./ha treatment was found to be optimum and effective against cotton sucking pests whiteflies and mites with higher yield in cotton. The predatory population (coccinellids and spiders) didn't show any significant difference among treatments indicating that, all the dosages of Fenazaquin 10 EC + Bifenthrin 4 EC were safe to natural enemies. Fenazaquin 10 EC + Bifenthrin 4 EC, application did not record any phytotoxic symptoms on cotton plants.

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