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Evaluation of bio-efficacy of cyantraniliprole 7.3 % W/W + diafenthiuron 36.4 % W/W SC against okra pests

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Abstract
The experiment was conducted to evaluate the bio efficacy of different doses of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC as foliar spray against pest complex of okra at Agricultural Research Station- Banswara (Rajasthan) during the year 2019-20 and 2020-21. The trial was laid out in randomized block design (RBD) with ten treatments *i.e.* Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 500, 625 & 700 ml; Cyantraniliprole 10.26% OD @ 600 ml; Diafenthiuron 50% WP @ 600g; Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml; Fenpropathrin 30% EC @ 340 ml; Tolfenpyrad 15% EC @ 1000 ml ha-1; untreated check and Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 1500 ml ha^{-1} (only for phytotoxicity test) replicated three times. The observations recorded at different days after sprays of insecticides depicted the lowest mean population of jassids (2.67 & 2.39/3 leaves/plant), whiteflies (3.27 & 2.89/3 leaves/plant) during the year 2019-20 and 2020-21, respectively) in Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 700 ml ha^{-1} with overall highest reduction during the year 2019-20 and 2020-21 over control. It was followed by Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 625 ml ha^{-1}. The minimum larval population (*Helicoverpa armigera*) and fruit damage (*Erias*) was also recorded in Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 700 ml ha^{-1} with highest fruit yield during both the years, followed by Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 625 ml ha^{-1}.

Keywords: Efficacy, ready mix molecule, cyantraniliprole 7.3% W/W + Diafenthiuron 36.4% W/W SC, okra, sucking pests, shoot and fruit borer, American bollworm

Introduction
Okra or lady finger (*Abelmoschus esculentus* L.), locally known as "*Bhindi*", is an important vegetable crop in India. It contains large quantities of carbohydrate, protein and vitamin C. Okra is a nutritious vegetable which plays an important role in meeting the vegetables' demand of the country when vegetables are scanty in the market (Anon., 2015) [1]. Okra is susceptible to the attack of various insect pests (including sucking pests and fruit & shoot borer) from seedling to fruiting stage, which reduce the production and productivity of the crop. As many as 72 species of insects have been recorded on okra (Rao and Rajendran, 2003) [2]. Among sucking pest complex, jassids; aphids; thrips; whitefly and mites are more serious (Atwal, 1994 [3] and Kale *et al.*, 2005) [4] and because 17.46 % yield loss and a failure in controlling them at initial stages, can cause up to 54.04% yield loss (Chaudhary and Dadeech, 1989 [5] and Anitha and Nandihalli, 2008) [6]. Jassids suck the cell sap usually from the ventral surface of the leaves and while feeding inject toxic saliva into plant tissues. Affected leaves turn yellowish, curled and plants show a stunted growth. Krishnaiah (1980) [7] reported about 40-56 per cent losses in okra due to leafhopper infestation. Whiteflies are responsible for transmitting yellow vein mosaic virus (Singh *et al.*, 2008) [8]. On the other hand, okra shoot and fruit borer, *Earias insulana* is also a very destructive pest. The infested shoots droop, wither and dry up. The larvae bore into the fruits and holes are plugged with excreta. Infested fruits get deformed and are left unfit for consumption. It causes 5.33 to 75.75 percent fruit loss in the field (Pareek and Bhargava, 2003) [9]. American bollworm, *Helicoverpa armigera* is also a serious pest (Rawat and Saha, 1973) [10], causing 45-57.1% damage to fruits (Shrinivasan and Krishna Kumar, 1983 [11] and Nderitu *et al.*, 2008) [12]. The overall damage due to insect pests accounts to 48.97% loss in fruit yield (Subbireddy *et al.*, 2018) [13]. Kanwar and Ameta, (2007) [14] reported about 69% losses in marketable yield due to attack of these insect pests. Though different non-chemical and chemical methods are developed under the IPM strategy, these pests are still in the fields and making the cultivation difficult for farmers.

The shoot and fruit borer also developed resistance against the conventional insecticides making it difficult to control (Kranthi *et al.*, 2002) [15]. Combination of two chemicals with different mode of action is the new strategy to reduce the development of resistance among insects (Kumar *et al.*, 2010) [16]. Hence, there is a need for new chemistry molecules with novel mode of action for the management of pest complex of okra.

Material and Methods

The field experiments were conducted at Agricultural Research Station, Borwat Farm, Banswara (Rajasthan) during 2019-20 and 2020-21 to evaluate the efficacy of different doses of Cyantraniliprole 7.3 % w/w + Diafenthiuron 36.4% w/w SC as foliar spray against pest complex of okra. The trial was laid out in randomized block design (RBD) with ten treatments including control, each replicated thrice. The treatments were Cyantraniliprole 7.3 % w/w + Diafenthiuron 36.4 % w/w SC @ 500, 625 & 700 ml; Cyantraniliprole 10.26 % OD @ 600 ml; Diafenthiuron 50 % WP @ 600g; Pyriproxyfen 5 % + Fenpropathrin 15 % EC @ 750ml; Fenpropathrin 30 % EC @ 340 ml; Tolfenpyrad 15% EC @ 1000 ml ha-1 and check were evaluated. For phytotoxicity test Cyantraniliprole 7.3 % w/w + Diafenthiuron 36.4% w/w SC @ 1500 ml ha^{-1} was also evaluated. The seeds of okra (Variety-Kirti) were sown at 50 × 35cm spacing. The plot size was kept 5.0 m × 5.25 m. All recommended package and practices were followed to raise the crop, except plant protection measures. The knapsack sprayer fitted with hollow cone nozzle and 500-liter water ha^{-1} was used to impose the spray. First spray was applied when target insect pest's population reached ETL and subsequent spray was given 15 days after 1st spray.

Observations on insect pest incidence were recorded from five fixed plants/plot which were tagged after selecting randomly in each treatment. The number of sucking pests namely whiteflies, aphids, jassids, and mites of okra were recorded from three leaves (top, middle and bottom) per plant before spray and 5, 7 and 15 days after application (DAA). The fruit damage caused by fruit borer *i.e.* Spotted fruit borer, *Earias* spp. was recorded on five randomly selected plants in each replication by counting the total number of fruits and damaged fruits at before application and 5, 10 and 15 days after each spray. Mean fruit damage percentage was calculated as below.

$$\text{Mean fruits damage}(\%) = \frac{\text{Number of damaged fruits}}{\text{Total number of fruits}} \times 100$$

The observation on the population of *Helicoverpa armigera* was recorded on five randomly selected plants at one day before spray and 5, 10 and 15 days after each application.

Phytotoxicity observation for treatments namely Cyantraniliprole 7.3 % w/w + Diafenthiuron 36.4% w/w SC@ 750ml ha^{-1}, Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4 % w/w SC@ 1500 ml/ha and untreated control were recorded at 0, 1, 3, 5, 7 and 10 days after each spray. The visual observations on the phytotoxicity symptoms viz. leaf injury, wilting, stunting, vein clearing, necrosis, chlorosis, epinasty and hyponasty etc. if any, on the crop due to application of test molecules were recorded using the scores shown in below table.

Table 1: Phytotoxicity rating on brinjal plant

Score	Percent crop affected	Score	Percent crop affected
0	No adverse effect	**6**	51-60
1	1-10	**7**	61-70
2	11-20	**8**	71-80
3	21-30	**9**	81-90
4	31-40	**10**	91-100
5	41-50		

Results and Discussion

Bio-efficacy of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4 % w/w SC against jassids

The pre-treatment population of jassids was in the range of 7.33 to 9.33 and 8.00 to 10.00/three leaves/plant before first spray during the years 2019-20 and 2020-21, respectively and all the treatments/plots were statistically at par. The observations recorded at different days after two sprays of insecticides depicted the lowest mean population of jassids (2.67 & 2.39/3 leaves/plant, during the year 2019-20 and 2020-21, respectively) in Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 700 $mlha^{-1}$ with overall highest reduction (78.76 and 83.20 % during the year 2019-20 and 2020-21, respectively) over control. It was followed by Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 625 ml ha^{-1}. Whereas, the highest mean population of jassids (12.56 & 14.22/3 leaves/plant during the year 2019-20 and 2020-21, respectively) was recorded in untreated check (Table 2 and 3).

Table 2: Effect of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC against jassids of okra (2019-20)

Treatments & dose	Population of jassids/ 3 leaves	Mean	% Reduction over control						
	Pre count	Days after spraying							
		First spray*	Second spray*						
		5	10	15	5	10	15		
T_1= Untreated check	7.67 (2.82)	9.33 (3.13)	10.67 (3.34)	12.00 (3.53)	13.33 (3.71)	14.67 (3.88)	15.33 (3.96)	12.56 (3.60)	-
T_2= Cyantraniliprole 7.3% + Diafenthiuron 36.4% SC @ 500 ml/ha	7.33 (2.77)	4.67 (2.26)	5.00 (2.34)	7.33 (2.79)	5.33 (2.40)	5.67 (2.46)	7.33 (2.78)	5.89 (2.53)	53.10
T_3= Cyantraniliprole 7.3% w/w + Diafenthiuron	10.00 (3.23)	3.33 (1.93)	3.00 (1.81)	5.00 (2.34)	3.33 (1.93)	3.00 (1.86)	4.67 (2.22)	3.72 (2.04)	70.35

36.4% SC @ 625 ml/ha									
T_4= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 750 ml/ha	8.67 (2.99)	2.33 (1.64)	2.00 (1.52)	4.00 (2.11)	2.33 (1.64)	2.00 (1.56)	3.33 (1.93)	2.67 (1.77)	78.76
T_5= Cyantraniliprole 10.26% OD @ 600 ml/ha	8.33 (2.93)	6.67 (2.67)	7.33 (2.79)	9.00 (3.07)	7.67 (2.83)	9.00 (3.06)	10.67 (3.32)	8.39 (2.98)	33.19
T_6= Diafenthiuron 50% WP @ 600 g/ha	9.00 (3.06)	4.00 (2.10)	3.67 (2.00)	5.33 (2.38)	4.00 (2.08)	4.00 (2.08)	5.67 (2.46)	4.44 (2.21)	64.60
T_7= Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha	8.33 (2.94)	6.33 (2.60)	6.67 (2.66)	8.33 (2.94)	7.67 (2.84)	8.33 (2.95)	10.33 (3.28)	7.94 (2.90)	36.73
T_8= Fenpropathrin 30% EC @ 340 ml/ha	9.33 (3.09)	7.00 (2.72)	7.67 (2.82)	9.33 (3.12)	8.67 (3.02)	9.33 (3.12)	11.00 (3.38)	8.83 (3.12)	29.70
T_9= Tolfenpyrad 15% EC @ 1000 ml/ha	10.33 (3.28)	3.00 (1.84)	2.67 (1.72)	4.33 (2.15)	3.00 (1.84)	2.67 (1.72)	4.33 (2.18)	3.33 (1.92)	73.45
SEM ±	0.31	0.21	0.26	0.22	0.23	0.26	0.25	-	-
CD at 5 %	NS	0.61	0.79	0.66	0.69	0.78	0.74	-	-

*Mean of three replications, Figures in parentheses are square root of √ x+ 0.5

Table 3: Effect of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC against jassids of okra (2020-21)

Treatments & dose	Population of jassids/ 3 leaves	Mean		% Reduction over control					
	Pre count	Days after spraying							
		First spray*		Second spray*					
		5	10	15	5	10	15		
T_1= Untreated check	8.67 (3.00)	10.33 (3.26)	12.67 (3.61)	14.33 (3.84)	14.67 (3.88)	16.33 (4.09)	17.00 (4.15)	14.22 (3.83)	-
T_2= Cyantraniliprole 7.3% + Diafenthiuron 36.4% SC @ 500 ml/ha	10.0 (3.22)	5.00 (2.28)	5.67 (2.47)	7.00 (2.72)	5.00 (2.32)	7.33 (2.79)	8.00 (2.86)	6.33 (2.61)	55.47
T_3= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 625 ml/ha	9.00 (3.06)	3.33 (1.93)	3.67 (2.03)	4.33 (2.15)	3.00 (1.86)	3.33 (1.90)	4.67 (2.21)	3.72 (2.04)	73.83
T_4= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 750 ml/ha	8.33 (2.91)	2.00 (1.56)	2.67 (1.74)	3.00 (1.86)	2.00 (1.56)	1.67 (1.46)	3.00 (1.86)	2.39 (1.70)	83.20
T_5= Cyantraniliprole 10.26% OD @ 600 ml/ha	8.00 (2.88)	6.33 (2.58)	7.67 (2.84)	9.00 (3.06)	8.33 (2.95)	10.67 (3.32)	12.33 (3.54)	9.06 (3.07)	36.33
T_6= Diafenthiuron 50% WP @ 600 g/ha	9.67 (3.15)	3.67 (2.02)	4.00 (2.09)	5.67 (2.45)	3.33 (1.93)	3.67 (2.00)	4.67 (2.24)	4.17 (2.14)	70.70
T_7= Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha	9.33 (3.09)	6.67 (2.66)	8.00 (2.89)	10.33 (3.28)	9.33 (3.12)	11.00 (3.37)	13.33 (3.67)	9.78 (3.20)	31.25
T_8= Fenpropathrin 30 % EC @ 340 ml/ha	8.00 (2.86)	7.00 (2.72)	8.67 (3.01)	11.00 (3.38)	9.67 (3.17)	11.33 (3.41)	14.00 (3.79)	10.28 (3.28)	27.73
T_9= Tolfenpyrad 15 % EC @ 1000 ml/ha	9.67 (3.17)	3.00 (1.86)	3.33 (1.93)	4.00 (2.08)	2.67 (1.77)	3.00 (1.84)	4.33 (2.18)	3.38 (1.94)	76.23
SEM ±	0.32	0.15	0.21	0.24	0.20	0.25	0.31	-	-
CD at 5 %	NS	0.46	0.64	0.72	0.59	0.74	0.94	-	-

*Mean of three replications, Figures in parentheses are square root of √ x+ 0.5

Bio-efficacy of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC against whiteflies

There was no significant difference in the whiteflies population among all the treatments a day before imposition of treatments with a population range of 19.67 to 23.00 & 16.33 to 18.33 whiteflies/3 leaves/plant during the year 2019-20 and 2020-21, respectively. The observations recorded at different days after two sprays of insecticides depicted the lowest mean population of whiteflies (3.27 & 2.89/3 leaves/plant, during the year 2019-20 and 2020-21, respectively) in Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 700 mlha^{-1} with overall highest reduction (83.37 and 87.38 % during the year 2019-20 and 2020-21, respectively) over control. It was followed by Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 625 ml ha^{-1}. Whereas, the highest mean population of white flies (26.94 & 22.89/3 leaves/plant during the year 2019-20 and 2020-21, respectively) was recorded in untreated check (Table 4 and 5).

Table 4: Effect of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC against whiteflies of okra (2019-20)

Treatments & dose	Population of whiteflies/3 leaves						Mean	% Reduction over control
	Pre count	Days after spraying						
		First spray*			Second spray*			
		5	10	15	5	10	15	
T_1= Untreated check	21.67 (4.70)	23.33 (4.87)	24.67 (5.01)	26.33 (5.17)	27.67 (5.30)	29.00 (5.43)	30.67 (5.58)	26.94 (5.24)	-
T_2= Cyantraniliprole 7.3% + Diafenthiuron 36.4% SC @ 500 ml/ha	22.33 (4.77)	7.00 (2.72)	7.33 (2.75)	8.67 (3.02)	7.33 (2.77)	8.67 (3.00)	9.33 (3.11)	8.06 (2.90)	70.10
T_3= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 625 ml/ha	21.00 (4.63)	5.00 (2.32)	4.67 (2.24)	5.67 (2.45)	4.33 (2.15)	5.33 (2.39)	7.00 (2.72)	5.33 (2.39)	80.21
T_4= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4%	19.67	3.33	2.67	4.33	2.33	3.00	4.00	3.27	87.86

SC @ 750 ml/ha	(4.48)	(1.90)	(1.76)	(2.18)	(1.64)	(1.86)	(2.00)	(1.97)	
T_5= Cyantraniliprole 10.26% OD @ 600 ml/ha	20.67 (4.59)	7.67 (2.85)	8.33 (2.94)	10.33 (3.28)	8.67 (3.01)	9.00 (3.05)	10.67 (3.31)	9.11 (3.09)	66.19
T_6= Diafenthiuron 50% WP @ 600 g/ha	21.67 (4.70)	4.67 (2.24)	4.33 (2.18)	5.67 (2.43)	3.67 (2.00)	5.00 (2.33)	6.67 (2.64)	5.00 (2.30)	81.44
T_7= Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha	21.00 (4.63)	5.33 (2.40)	4.67 (2.24)	6.67 (2.66)	5.00 (2.32)	5.33 (2.40)	7.33 (2.77)	5.72 (2.48)	78.76
T_8= Fenpropathrin 30% EC @ 340 ml/ha	21.67 (4.70)	8.00 (2.90)	8.67 (2.99)	10.33 (3.28)	8.67 (3.01)	11.00 (3.37)	19.67 (4.48)	10.00 (3.22)	62.89
T_9= Tolfenpyrad 15% EC @ 1000 ml/ha	23.00 (4.84)	7.33 (2.77)	7.67 (2.81)	8.67 (3.00)	6.00 (2.53)	7.33 (2.78)	9.33 (3.12)	7.72 (2.85)	71.34
SEM ±	0.20	0.23	0.20	0.22	0.23	0.24	0.26	-	-
CD at 5 %	NS	0.70	0.59	0.67	0.70	0.71	0.79	-	-

*Mean of three replications, Figures in parentheses are square root of √ x+ 0.5

Table 5: Effect of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC against whiteflies of okra (2020-21)

Treatments & dose	Population of whiteflies/3 leaves							Mean	% Reduction over control
	Pre count	Days after spraying							
		First spray*			Second spray*				
		5	10	15	5	10	15		
T_1= Untreated check	17.33 (4.21)	19.00 (4.41)	21.33 (4.65)	22.00 (4.73)	23.00 (4.84)	25.33 (5.07)	26.67 (5.21)	22.89 (4.83)	-
T_2= Cyantraniliprole 7.3% + Diafenthiuron 36.4% SC @ 500 ml/ha	18.33 (4.32)	5.33 (2.40)	6.00 (2.53)	6.67 (2.65)	5.33 (2.40)	6.67 (2.66)	9.00 (3.07)	6.50 (2.64)	71.60
T_3= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 625 ml/ha	17.67 (4.25)	4.00 (2.18)	3.67 (2.00)	4.33 (2.15)	3.33 (1.88)	5.00 (2.32)	5.33 (2.38)	4.27 (2.18)	81.34
T_4= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 750 ml/ha	17.00 (4.16)	2.67 (1.74)	2.33 (1.64)	3.00 (1.81)	2.00 (1.56)	3.00 (1.81)	4.33 (2.18)	2.89 (1.81)	87.38
T_5= Cyantraniliprole 10.26% OD @ 600 ml/ha	18.00 (4.29)	6.00 (2.53)	6.33 (2.55)	7.00 (2.70)	6.00 (2.53)	7.33 (2.77)	9.00 (3.03)	6.94 (2.70)	69.66
T_6= Diafenthiuron 50% WP @ 600 g/ha	16.33 (4.09)	4.00 (2.08)	3.67 (2.02)	4.33 (2.18)	3.33 (1.93)	4.33 (2.16)	6.33 (2.59)	4.33 (2.15)	81.00
T_7= Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha	17.00 (4.17)	4.67 (2.26)	4.33 (2.18)	4.67 (2.22)	4.33 (2.15)	5.33 (2.39)	5.67 (2.47)	4.83 (2.30)	78.16
T_8= Fenpropathrin 30% EC @ 340 ml/ha	17.67 (4.26)	6.33 (2.61)	7.67 (2.86)	9.00 (3.08)	8.33 (2.96)	9.67 (3.18)	12.67 (3.62)	8.94 (3.07)	60.92
T_9= Tolfenpyrad 15% EC @ 1000 ml/ha	18.00 (4.30)	5.00 (2.34)	5.33 (2.38)	6.33 (2.59)	5.00 (2.32)	6.67 (2.65)	8.33 (2.92)	6.11 (2.56)	73.30
SEM ±	0.21	0.20	0.19	0.25	0.23	0.20	0.20	-	-
CD at 5 %	NS	0.59	0.59	0.74	0.70	0.61	0.59	-	-

*Mean of three replications, Figures in parentheses are square root of √ x+ 0.5

Bio-efficacy of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC against mites

The pest population of mites was not observed at the time of first application. However, it was observed at the time of second application during both years. The pre-treatment population of mites was uniform and no significant difference was observed among the treatments/plots with respect to number of 22.33 to 27.67 & 15.00 to 17.67 per three leaves and all the treatments were statistically at par before second spray during the year 2019-20 and 2020-21, respectively. The minimum number of mites population with a mean of 5.89 and 4.00 was recorded in Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 750 ml/ha after second spray and statistically at par with its lower dose *i.e.* Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 625 ml/h and Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha. Diafenthiuron 50 WP @ 600 g/ha was found next best treatment. Whereas, maximum population of mites with mean of 27.89 & 22.33/3leaves was recorded in untreated check after second spray during the year 2019-20 and 2020-21, respectively (Table 6).

Table 6: Effect of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC against mites of okra (2019-20 & 2020-21

Treatments & dose	2019-20						2020-21					
	Population of mites /3 leaves				Mean	% Reduction over control	Population of mites /3 leaves				Mean	% Reduction over control
	Pre count	Days after spraying					Pre count	Days after spraying				
		Second spray*						Second spray*				
		5	10	15				5	10	15		
T_1= Untreated check	25.67 (5.11)	26.33 (5.17)	28.33 (5.35)	29.00 (5.42)	27.89 (5.32)	-	16.67 (4.13)	18.00 (4.29)	21.00 (4.63)	22.33 (4.77)	20.44 (4.57)	-
T_2= Cyantraniliprole 7.3% + Diafenthiuron 36.4% SC @ 500 ml/ha	24.67 (5.00)	11.33 (3.43)	10.00 (3.20)	13.33 (3.65)	11.55 (3.39)	58.58	15.67 (4.01)	8.00 (2.82)	7.00 (2.64)	10.00 (3.16)	8.33 (2.88)	59.24
T_3= Cyantraniliprole 7.3%	23.33	8.33	7.33	9.00	8.22	70.52	15.00	5.67	4.67	6.67	5.67	72.28

w/w + Diafenthiuron 36.4% SC @ 625 ml/ha	(4.85)	(2.95)	(2.75)	(3.07)	(2.95)		(3.93)	(2.47)	(2.24)	(2.66)	(2.48)	
T_4= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 750 ml/ha	22.33 (4.73)	5.67 (2.46)	4.67 (2.22)	6.33 (2.75)	5.55 (2.35)	80.10	15.00 (3.89)	4.33 (2.16)	3.67 (2.02)	5.00 (2.32)	4.33 (2.18)	78.80
T_5= Cyantraniliprole 10.26% OD @ 600 ml/ha	26.00 (5.14)	18.33 (4.33)	17.67 (4.24)	20.33 (4.54)	18.78 (4.39)	32.67	17.00 (4.16)	14.00 (3.80)	15.33 (3.97)	17.00 (4.17)	15.44 (3.98)	24.46
T_6= Diafenthiuron 50% WP @ 600 g/ha	24.33 (4.97)	10.00 (3.22)	9.00 (3.07)	11.00 (3.31)	10.00 (3.32)	64.14	16.00 (4.04)	7.00 (2.70)	6.67 (2.67)	8.67 (3.01)	7.44 (2.81)	63.59
T_7= Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha	24.67 (5.00)	8.67 (3.02)	7.67 (2.82)	9.67 (3.15)	8.67 (3.02)	68.92	15.67 (3.98)	6.00 (2.53)	5.33 (2.38)	7.00 (2.70)	6.11 (2.56)	70.11
T_8= Fenpropathrin 30% EC @ 340 ml/ha	25.00 (5.04)	11.67 (3.48)	10.67 (3.32)	14.33 (3.83)	12.22 (3.56)	56.18	17.67 (4.26)	8.00 (2.88)	6.67 (2.67)	9.33 (3.13)	8.00 (2.89)	60.86
T_9= Tolfenpyrad 15% EC @ 1000 ml/ha	27.67 (5.30)	16.00 (4.05)	17.00 (4.14)	19.33 (4.45)	17.44 (4.22)	37.45	17.00 (4.17)	11.67 (3.48)	14.00 (3.80)	16.67 (4.13)	14.11 (3.81)	30.98
SEM ±	0.29	0.23	0.18	0.25	-	-	0.28	0.18	0.20	0.22	-	-
CD at 5 %	NS	0.68	0.53	0.75	-	-	NS	0.53	0.60	0.65	-	-

*Mean of three replications, Figures in parentheses are square root of √ x+ 0.5

Bio-efficacy of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC against *Helicoverpa armigera*

The larval population of *Helicoverpa armigera* was not observed at the time of first spray application. However, it was observed at the time of second application. The pre-treatment population of *Helicoverpa armigera* larvae was uniform and no significant difference was observed among the treatments/plots with respect to number of 1.00 to 2.67 & 0.67 to 2.33 per five plants before second spray during the year 2019-20 and 2020-21, respectively. The minimum mean population of *Helicoverpa armigera* with a mean of 0.67 and 0.89 with highest per cent control (89.29 & 87.30 %) over check was recorded in Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 750 ml/ha after second spray during the year 2019-20 and 2020-21, respectively and statistically at par with its lower dose *i.e.* Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 625 ml/ha followed by Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha and Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 500 ml/ha. Whereas, maximum population of *Helicoverpa armigera* with mean of 6.22 and 7.00 was recorded in untreated check (Table 7).

Table 7: Effect of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC against *Helicoverpa armigera* of okra (2019-20 & 2020-21

Treatments & dose	2019-20						2020-21					
	Mean per cent fruit damage				Mean	% Reduction over control	Mean per cent fruit damage				Mean	% Reduction over control
	Pre count	Days after spraying Second spray*					Pre count	Days after spraying Second spray*				
		5	10	15				5	10	15		
T_1= Untreated check	2.00 (1.56)	3.67 (2.04)	6.00 (2.54)	9.00 (3.07)	6.22 (2.59)	-	1.67 (1.46)	4.00 (2.11)	7.33 (2.79)	9.67 (3.18)	7.00 (2.74)	-
T_2= Cyantraniliprole 7.3% + Diafenthiuron 36.4% SC @ 500 ml/ha	2.33 (1.66)	1.33 (1.34)	1.67 (1.46)	3.00 (1.86)	2.00 (1.57)	67.86	2.00 (1.56)	1.33 (1.34)	2.00 (1.56)	3.67 (2.04)	2.33 (1.68)	66.67
T_3= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 625 ml/ha	1.33 (1.34)	1.00 (1.22)	1.00 (1.22)	1.67 (1.46)	1.22 (1.31)	80.36	1.00 (1.22)	0.67 (1.05)	1.00 (1.22)	2.67 (1.76)	1.44 (1.39)	79.37
T_4= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 750 ml/ha	1.00 (1.22)	0.67 (1.05)	0.33 (0.88)	1.00 (1.22)	0.67 (1.08)	89.29	0.67 (1.05)	0.33 (0.88)	0.67 (1.05)	1.67 (1.46)	0.89 (1.18)	87.30
T_5= Cyantraniliprole 10.26% OD @ 600 ml/ha	2.33 (1.68)	1.67 (1.46)	2.00 (1.56)	3.00 (1.86)	2.22 (1.64)	64.29	1.67 (1.46)	1.33 (1.34)	2.33 (1.68)	4.00 (2.10)	2.56 (1.73)	63.49
T_6= Diafenthiuron 50% WP @ 600 g/ha	2.67 (1.74)	3.00 (1.86)	4.33 (2.18)	7.67 (2.85)	5.20 (2.29)	19.61	2.00 (1.56)	3.00 (1.87)	5.67 (2.46)	7.67 (2.85)	5.44 (2.43)	22.22
T_7= Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha	1.67 (1.46)	1.33 (1.34)	1.67 (1.46)	2.33 (1.68)	1.78 (1.51)	71.43	1.00 (1.22)	1.00 (1.22)	1.67 (1.46)	3.00 (1.84)	1.89 (1.54)	73.02
T_8= Fenpropathrin 30% EC @ 340 ml/ha	1.67 (1.46)	1.67 (1.46)	2.00 (1.56)	2.67 (1.76)	2.11 (1.61)	66.07	1.33 (1.34)	1.33 (1.34)	2.00 (1.58)	4.00 (2.11)	2.44 (1.72)	65.08
T_9= Tolfenpyrad 15% EC @ 1000 ml/ha	2.00 (1.56)	2.67 (1.77)	4.00 (2.11)	7.33 (2.79)	4.67 (2.22)	24.91	2.33 (1.68)	3.67 (2.04)	6.00 (2.54)	8.00 (2.91)	5.89 (2.52)	15.87
SEM ±	0.16	0.10	0.15	0.15	-	-	0.13	0.10	0.13	0.14	-	-
CD at 5 %	NS	0.31	0.43	0.44	-	-	NS	0.31	0.40	0.43	-	-

*Mean of three replications, Figures in parentheses are square root of √ x+ 0.5

Bio-efficacy of cyantraniliprole 7.3% w/w + diafenthiuron 36.4% w/w SC against *Earias* spp

The fruit damage by *Earias* spp did not observed at the time of first application. However, it was observed at the time of second application. The pre-treatment damage of *Earia* spp was uniform and no significant difference was observed among the treatments/plots with respect to per cent damage of 2.60 to 4.07 and 2.30 to 3.93 before second spray. The minimum per cent fruit damage of *Earias* spp with a mean of 1.37 and 1.16 with highest per cent control (87.37 & 90.00 %)

was recorded in Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 750 ml/ha at different days after sprays, respectively and statistically at par with its lower dose *i.e.* Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 625 ml/ha. Cyantraniliprole 10.26% OD @ 600 ml/ha was found next best treatment. Whereas, maximum damage of *Earias* spp with mean of 10.82 and 11.58 was recorded in untreated check during the year 2019-20 and 2020-21, respectively (Table 8).

Table 8: Effect of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC against *Earias* spp of okra (2019-20 & 2020-21)

Treatments & dose	2019-20						2020-21					
	Mean per cent fruit damage				Mean	% Reduction over control	Mean per cent fruit damage				Mean	% Reduction over control
	Pre count	Days after spraying Second spray*					Pre count	Days after spraying Second spray*				
		5	10	15				5	10	15		
T_1= Untreated check	4.03 (11.55)	8.47 (16.80)	10.43 (18.75)	13.57 (21.47)	10.82 (19.10)	-	3.20 (10.26)	7.63 (16.04)	11.30 (19.62)	15.80 (23.40)	11.58 (19.87)	-
T_2= Cyantraniliprole 7.3% + Diafenthiuron 36.4% SC @ 500 ml/ha	3.13 (10.11)	2.47 (9.02)	2.93 (9.76)	3.90 (11.25)	3.10 (10.12)	71.36	2.43 (8.94)	1.83 (7.60)	2.63 (9.19)	3.90 (11.37)	2.79 (9.55)	75.90
T_3= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 625 ml/ha	2.83 (9.68)	1.77 (7.60)	1.90 (7.92)	2.33 (8.73)	2.00 (8.12)	81.52	2.30 (8.68)	1.40 (6.76)	1.73 (7.50)	2.73 (9.36)	1.96 (7.97)	83.07
T_4= Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% SC @ 750 ml/ha	2.60 (9.24)	1.17 (6.14)	1.23 (6.22)	1.70 (7.33)	1.37 (6.71)	87.37	2.20 (8.49)	0.80 (5.07)	0.87 (5.31)	1.53 (7.08)	1.16 (6.14)	90.00
T_5= Cyantraniliprole 10.26% OD @ 600 ml/ha	3.07 (10.07)	2.37 (8.81)	2.70 (9.43)	3.57 (10.86)	2.88 (9.67)	73.38	2.57 (9.20)	1.80 (7.63)	2.40 (8.82)	3.87 (11.20)	2.69 (9.39)	76.78
T_6= Diafenthiuron 50% WP @ 600 g/ha	4.07 (11.62)	6.33 (14.40)	8.37 (16.80)	10.80 (19.11)	8.50 (16.89)	21.46	3.93 (11.41)	6.40 (14.65)	9.73 (18.16)	11.73 (19.98)	9.28 (17.72)	19.87
T_7= Pyriproxyfen 5% + Fenpropathrin 15% EC @ 750 ml/ha	2.87 (9.74)	2.23 (8.57)	2.67 (9.35)	3.20 (10.28)	2.70 (9.51)	75.04	2.47 (9.00)	1.77 (7.43)	2.30 (8.63)	3.50 (10.63)	2.52 (9.12)	78.21
T_8= Fenpropathrin 30% EC @ 340 ml/ha	3.07 (10.04)	2.60 (9.26)	3.13 (10.16)	4.07 (11.60)	3.27 (10.39)	69.82	2.77 (9.56)	2.10 (8.21)	3.27 (10.40)	4.70 (12.43)	3.36 (10.55)	71.02
T_9 = Tolfenpyrad 15% EC @ 1000 ml/ha	4.00 (11.54)	6.60 (14.87)	8.60 (17.04)	11.20 (19.49)	8.80 (17.23)	18.69	3.43 (10.56)	6.07 (14.26)	8.57 (17.00)	11.70 (20.01)	8.78 (17.24)	24.17
SEM ±	0.57	0.77	0.64	0.73	-	-	0.67	0.79	0.80	0.98	-	-
CD at 5 %	NS	2.32	1.92	2.19	-	-	NS	2.35	2.39	2.94	-	-

*Mean of three replications, Figures in parentheses are arcsine transformed values

Effect on yield (q/ha)

The maximum fruit yield of 118.30 and 113.57 q/ha was recorded in Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 750 ml/ha during the year 2019-20 and 2020-21, respectively. It is statistically at par with its lower doses *i.e.* Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 625 ml/ha, during both the years. Whereas, minimum fruit yield of 86.63 and 83.67q/ha was recorded in untreated check during 2019-20 and 2020-21, respectively (Table 9).

Table 9: Effect of Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC on yield of okra during 2019-20 and 2020-21

Tr. No.	Treatments	Yield (q/ha)	
		2019-20	2020-21
1	Untreated check	86.63	83.67
2	Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 500 ml/ha	107.57	103.53
3	Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 625 ml/ha	114.20	109.63
4	Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC @ 750 ml/ha	118.30	113.57
5	Cyantraniliprole 10.26% OD @ 600 ml/ha	102.73	96.83
6	Diafenthiuron 50% WP @ 600 g/ha	100.63	99.63
7	Pyriproxyfen 5 % + Fenpropathrin 15% EC @ 750 ml/ha	105.47	100.87
8	Fenpropathrin 30 % EC @ 340 ml/ha	98.93	95.60
9	Tolfenpyrad 15% EC @ 1000 ml/ha	101.97	99.10
SEM ±		2.18	3.16
CD at 5 %		6.55	9.47

Effects on okra plants

The visual symptoms recorded on phytotoxicity symptoms showed that Cyantraniliprole 7.3% w/w + Diafenthiuron 36.4% w/w SC did not cause phytotoxicity in any form (leaf injury, wilting, stunting, vein clearing, necrosis, chlorosis, epinasty and hyponasty) even spray up to 1500 ml/ha.

Conclusion

Cyantraniliprole 7.3 % w/w + Diafenthiuron 36.4 % w/w SC @ 750 ml/ha was found more effective in controlling the population of jassids, whiteflies, mites and fruit borers (*Helicoverpa armigera* and *Earias* spp) and statistically at par with its lower dose *i.e.* Cyantraniliprole 7.3 % w/w + Diafenthiuron 36.4% w/w SC @ 625 ml/ha and found safe on crop as it did not cause phytotoxicity.

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