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EFFECT OF CYANTRANILIPROLE 10.26 OD AGAINST MAJOR LEPIDOPTERAN AND SUCKING INSECTS ON OKRA AND CABBAGE

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Abstract: The present study is conducted to evaluate bio-efficacy of cyantraniliprole during late *kharif* of 2020 against major sucking and lepidopteran insects of okra and cabbage. On okra, cyantraniliprole @ 120 g a.i./ha depicted the highest population reduction of *Aphis gossypii* (79.57 %), *Bemisia tabaci* (82.25 %), *Helicoverpa armigera* (91.98 %), *Earias vitella* (94.69 %) and *Spodoptera litura* (94.95 %), which was significantly at par with 90 g a.i./ha. On cabbage, cyantraniliprole @ 75 g a.i./ha resulted highest population reduction of *Brevicoryne brassicae* (87.50 %), *Lipaphis erysimi* (87.00 %), *Plutella xylostella* (90.55 %) and *Spodoptera litura* (89.79 %). Such dose in cabbage was statistically at par with 60 g a.i./ha to manage these pests. Significantly at par yield was also obtained for both of these respective doses of cyantraniliprole on okra (10.90 to 10.87 t/ha) and cabbage (61.67 to 61.33 t/ha), respectively. Based on the result, it can be concluded that cyantraniliprole at 90-120 g.a.i./ha on okra and 60 -75 g a.i./ha on cabbage can be recommended to manage above mentioned major respective insects.

Keywords: Efficacy, Cyantraniliprole, Okra, Cabbage, Sucking, Lepidopteran, Insect

INTRODUCTION

Okra or Bhendi or Lady's finger [*Abelmoschus esculentus* (L.) Moench] is one of the important delicious vegetable crops grown in India. Okra can be cultivated all-round the year especially in the tropical and sub-tropical countries (Khoso, 1994). In India, it can be grown throughout the year but summer and kharif are generally most favourable seasons for its cultivation. Globally India ranks first in okra production having area of 509 thousand hectares with an annual production of 6094.9 thousand tons and productivity of 12 million tonnes/ha (Moulana *et al*., 2020). The major okra producing states in India are Uttar Pradesh, Bihar, Orissa, West Bengal, Andhra Pradesh, Karnataka and Assam (Anonymous, 2011). Apart from being a very good vegetable crop, fruits of okra are also used in culinary preparation as sliced and dried pieces and also used as thickening gravies and soups because of mucilage content. They are also good source of vitamins (A, B, C and D), proteins, carbohydrates, salts, minerals (iron, calcium, magnesium, iodine, potassium etc.) and acids (rhamnose, galacturonic and amino acid) (Arkroud, 1963; Hamon and Charrier, 1985; Wagon *et al*., 2014). Various biotic and abiotic factors are known to affect the productivity of the bhendi (Jiskani, 2006). Among the biotic factor ravages caused by insect pests during different growth stages of the crop are significant (Sarkar *et al*., 2016). As high as 72 species of insects have been recorded on okra (Srinivasan and Rajendran, 2003). Among different insect pests, few viz., sucking pests like aphids, whiteflies, leafhoppers etc. and borers & defoliators like fruit borer, fruit & shoot borer, tobacco caterpillar and other minor pests are the pests which cause considerable yield loss in okra crop (Pal, 2013). Research

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revealed that a total of 69% of the okra yield was affected by insect pests (Mani *et al*., 2005).

Similarly, cabbage is another important vegetable crop grown in different parts of India (Sahu *et al*, 2019) and is used as salad, boiled vegetable, in curries, pickling as well as dehydrated vegetable (Bana *et al*., 2012). It prefers winter temperature for optimum growth and yield, although today off season cultivation is also increasing with the introduction of suitable varieties. India ranks second after China for cabbage production with 12 % of world production (Sharma *et al*, 2017). In India, the area under cabbage cultivation is around 4.02 lakh hectare with 90.35 lakh tones production during 2018 The major cabbage producing states are West Bengal, Odisha, Madhyapradesh, Bihar, Assam, Gujrat, Chattisgarh, Haryana, Jharkhand and Uttarpradesh. West Bengal is the leading producer of cabbage (22.89 lakh ton) in India but the productivity is highest in Uttarpradesh (33.44 t/ha) (Majid, 2020). Various nutrients are available in cabbage including calcium, zinc, molybdenum, thiamine, vitamin C, folic acid, protein, fibre, phosphorus, magnesium, copper, chromium, potassium, riboflavin, choline, folic acid, carbohydrate, iron, fat, manganese, carotene and niacin (Tamta *et al*., 2014). Its production is possible only with intensive agricultural technology and chemical protection, because cabbage is also attacked by a large number of harmful insects. Thirty seven insect pests have been reported to feed on cabbage in India (Lal, 1975). Most important insects that can cause huge economic losses to the crop are aphids (*Brevicoryne brassicae, Lipaphis erysimi*) (Bana *et al*., 2012), diamond back moth (*Plutella xylostella*) and tobacco caterpillar (*Spodoptera litura*) (Sahu *et al*., 2019)

Among the different pest management options, use of insecticides is most important and widely used management practice (Chirinos *et al*., 2020) that substantially reduces the yield losses caused by insect pests. Due to lack of proper knowledge about the insecticides, farmers are indiscriminately spraying conventional chemicals that have led to increase in cost of cultivation and causing environmental pollution (Guo *et al*., 1999; Handigol and Kulkarni, 2010). The evaluation of recently available effective insecticides could help in choosing the suitable insecticide for combating both sucking and lepidopteran insect pests of okra and cabbage. Keeping this in view, the present investigation was carried out to evaluate the efficacy of recently introduced novel insecticide; cyantraniliprole 10.26 OD at different concentrations along with recently recommended other insecticides against major lepidopteran and sucking insects on okra and cabbage.

MATERIALS AND METHODS

The experiment was conducted at research farm of College of Agriculture, BCKV, Burdwan, West Bengal, India during late *kharif* 2020. The trial crops i.e okra (var. NS 862) and cabbage (var. Rare ball) were raised in randomized block design with 3 replications in 5 m x 5 m individual plot for each treatment maintaining recommended horticultural package of practices. The number of treatments were seven [cyantraniliprole 10.26 OD at 4 different concentrations (i.e. 0.06, 0.12, 0.18 and 0.24 %), thiamethoxam 25 WG (0.02 %), emamectin benzoate 5 SG (0.03 %) and untreated control in okra and cyantraniliprole 10.26 OD again at 4 different concentrations (i.e. 0.06, 0.9, 0.12 and 0.15 %), chlorfluazuron 5.4 EC (3 %), acetamiprid 20 SP (0.015 %) and untreated control in cabbage] for both the said crops. Three sprays @ 500 litre water ha^{-1} are given at 15 days interval using knapsack sprayer fitted with hollow cone nozzle starting first spray at 40 days after transplanting (cabbage) and sowing (okra).

In both crops, the target pest wise population was recorded at 0, 3, 7 and 10 days after each spray from randomly selected 5 plants per plot and accordingly the percent (%) insect reduction was calculated over untreated Control. Data recorded in okra for aphid, *Aphis gossypii* and whitefly, *Bemisia tabaci* was represented as number per plant based on population from 3 and 5 fully expanded leaves of upper plant canopy, respectively. Here, observations for *Helicoverpa armigera* and *Earias vitella* were also recorded by counting of larval numbers and percent (%) fruit damage. Whereas, only larval numbers were counted for *Spodoptera litura* and expressed as number of larvae per 5 plants. Similarly, in cabbage data recorded on population of aphid (*Brevicoryne brassicae* and *Lipaphis erysimi*) was expressed as numbers per plant. Whereas, it was expressed as numbers/5 plants for *Plutella xylostella* and *Spodoptera litura*.

Plot wise yield was recorded at each picking for both the crops. Total respective marketable yield was calculated after multiple numbers of pickings on per plot basis. The yield was expressed in ton per ha.

The data were subjected to appropriate transformations wherever necessary and analyzed statistically as per valid experimental design using MSTATC.

RESULTS

Efficacy of cyantraniliprole 10.26 OD against major sucking and lepidopteran insects of okra Sucking insects

Aphid (*Aphis gossypii*)

There was non-significant difference with respect to aphid population before spraying among treatments and the count ranged from 17.67 to 19.00 aphids/3 leaves/plant. Whereas, aphid's population started to show significant differences after the spray of chemicals (Table 1).

The observations recorded at different days after three sprays of insecticides depicted the lowest mean population of aphids (5.07/3 leaves/plant) in Cyantraniliprole 10.26 % OD @120 g a.i. /ha with the overall highest reduction (79.57 %) of pest over control. It was at par with 78.97 % reduction by cyantraniliprole 10.26 % OD @ 90 g a.i./ha receiving 5.22 aphids/3 leaves/ plant. Whereas, the highest mean population of aphids (24.80 /3 leaves/plant) was recorded in untreated control treatment (Table 1) followed by emamectin Benzoate 5% SG @ 8.5 g a.i./ ha (24.80/3 leaves/plant), cyantraniliprole 10.26 OD @ 30 g a.i./ha (9.94 /3 leaves/plant), thiamethoxam 25 WG @ 25 g a.i./ha (9.60 /3 leaves/plant) and cyantraniliprole 10.26 % OD @ 60 g a.i./ha (9.00 /3 leaves/plant)

Whitefly (*Bemisia tabaci*)

The data recorded on whitefly population (Table 2) depicted non-significant differences before spraying and its population ranged from 13.67 to 14.07/5 leaves/plant. Whereas, significant differences among the treatments with respect to whitefly population was started to notice at different days after the imposition of insecticides.

The observations recorded at different days after three sprays of insecticides depicted the lowest mean population of whitefly (3.29/5 leaves/plant) in cyantraniliprole 10.26 OD @120 g a.i. /ha with the overall highest reduction (82.25 %) of pest over control. It was at par with cyantraniliprole 10.26 % OD @ 90 g a.i./ha (3.43/5 leaves/plant, 81.49 % reduction). Whereas, the highest mean population of whitefly (17.91/5 leaves/plant) was recorded in untreated control treatment followed by cyantraniliprole 10.26 OD @ 30 g a.i./ha (8.08/5 leaves/plant), emamectin benzoate 5 SG @ 8.5 g a.i./ha (6.30/5 leaves/ plant), cyantraniliprole 10.26 OD @ 60 g a.i./ha (5.70/5 leaves/plant) and thiamethoxam 25 WG @ 25 g a.i./ha (5.70/5 leaves/plant).

Lepidopteran insects

Fruit borer (*Helicoverpa armigera*)

The observations made on fruit borer larval population (1.27 to 1.37 larva/ 5 plants) depicted no significant difference among the different treatments before spraying. Significant differences among the treatments started to notice at different days after the imposition of the chemicals (Table 3). Significantly the lowest mean larval population (0.30/5 plants) of fruit borer was recorded in cyantraniliprole 10.26 OD @120 g a.i./ha which was found on par (0.32/5 plants) with 90 g a.i./ha. The respective overall reduction of larval population over untreated control was 91.98 and 90.74 %. Untreated control treatment has recorded the highest mean larval population of fruit borer (2.32 larva/ 5 plants) followed by thiamethoxam 25 WG @ 25 g a.i./ ha (1.30 larva/plant), cyantraniliprole 10.26 OD @ 30 g a.i./ha (1.29 larva/ 5 plants), emamectin benzoate 5 SG @ 8.5 g a.i./ha (1.6 larva/ 5 plants) and cyantraniliprole 10.26 OD @ 60 g a.i./ha (0.60 larva/ 5 plants).

The percent fruit damage (23.59 to 29.70 %) recorded in Table 4 was non-significant among the treatments before the spray. Significant differences among the treatments was started

Table 1: Efficacy of Cyantraniliprole 10.26 % OD against aphids, *Aphis gossypii* population/3 leaves/plant in okra crop

Treatments	*Dose g a.i./ha*	*Pre-count*	*First spray*			*Second spray*			*Third spray*			*Mean*	*Overall % ROC*
			3 DAS	*7 DAS*	*10 DAS*	*3 DAS*	*7 DAS*	*10 DAS*	*3 DAS*	*7 DAS*	*10 DAS*		
Cyantraniliprole 10.26 % OD	30	17.67 (4.26)	11.67 (3.49)	10.87 (3.37)	12.20 (3.56)	8.67 (3.03)	8.33 (2.97)	10.33 (3.29)	7.20 (2.77)	9.87 (3.22)	10.33 (3.29)	9.94	59.92
Cyantraniliprole 10.26 % OD	60	18.47 (4.35)	11.07 (3.40)	10.47 (3.31)	11.60 (3.48)	8.13 (2.94)	7.40 (2.81)	8.87 (3.06)	6.67 (2.68)	8.13 (2.94)	8.67 (3.03)	9.00	63.71
Cyantraniliprole 10.26 % OD	90	18.40 (4.35)	7.07 (2.75)	6.33 (2.61)	7.07 (2.75)	5.53 (2.46)	4.87 (2.32)	5.27 (2.40)	3.27 (1.94)	2.87 (1.83)	4.67 (2.27)	5.22	78.97
Cyantraniliprole 10.26 % OD	120	18.67 (4.38)	6.93 (2.73)	6.27 (2.60)	6.93 (2.73)	5.27 (2.40)	4.73 (2.29)	5.13 (2.37)	3.07 (1.89)	2.80 (1.82)	4.47 (2.23)	5.07	79.57
Thiamethoxam 25% WG	25	18.60 (4.37)	11.20 (3.42)	10.60 (3.33)	12.53 (3.61)	8.60 (3.02)	8.07 (2.93)	9.47 (3.16)	7.00 (2.74)	8.53 (3.01)	10.40 (3.30)	9.60	61.29
Emamectin Benzoate 5% SG	8.5	19.00 (4.41)	12.20 (3.56)	11.67 (3.49)	13.93 (3.80)	9.87 (3.22)	9.20 (3.11)	11.87 (3.52)	8.67 (3.03)	11.33 (3.44)	12.20 (3.56)	11.22	54.78
Untreated control	-	18.13 (4.32)	19.27 (4.45)	19.60 (4.48)	21.93 (4.74)	24.80 (5.03)	25.87 (5.13)	26.17 (5.16)	28.00 (5.34)	28.53 (5.39)	29.00 (5.43)	24.80	-
S.Em±	-	0.06	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.05	0.06	-	-
CD@5%	-	0.19	0.08	0.10	0.08	0.10	0.08	0.11	0.11	0.15	0.18	-	-

DAS – Day After Spray, Figures in the parenthesis are square root $(\sqrt{x+0.5})$ transformed values, ROC – Reduction Over Control, NS – Non significant

Table 2. Efficacy of Cyantraniliprole 10.26 % OD against whitefly, *Bemesia tabaci* population in okra crop (5 leaves/plant)

Treatments	*Dose g a.i./ha*	*Pre-count*	*First spray*			*Second spray*			*Third spray*			*Mean*	*% ROC*
			3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS		
Cyantraniliprole 10.26 % OD	30	13.67 (3.76)	9.60 (3.18)	8.67 (3.03)	10.00 (3.24)	7.67 (2.86)	6.87 (2.71)	8.67 (3.03)	7.33 (2.80)	6.87 (2.71)	7.00 (2.73)	8.08	56.43
Cyantraniliprole 10.26 % OD	60	13.80 (3.78)	7.00 (2.74)	6.40 (2.63)	7.07 (2.75)	5.40 (2.43)	4.47 (2.23)	5.80 (2.51)	5.13 (2.37)	4.80 (2.30)	5.27 (2.40)	5.70	69.22
Cyantraniliprole 10.26 % OD	90	13.93 (3.80)	4.13 (2.15)	3.20 (1.92)	3.87 (2.09)	4.00 (2.12)	3.33 (1.96)	3.60 (2.02)	3.07 (1.89)	2.60 (1.76)	3.07 (1.89)	3.43	81.49
Cyantraniliprole 10.26 % OD	120	13.87 (3.79)	4.07 (2.13)	3.13 (1.91)	3.73 (2.06)	3.87 (2.20)	3.20 (1.92)	3.27 (1.94)	2.93 (1.85)	2.47 (1.72)	2.93 (1.85)	3.29	82.25
Thiamethoxam 25% WG	25	14.07 (3.82)	6.27 (2.60)	6.00 (2.55)	7.20 (2.77)	5.93 (2.54)	5.27 (2.40)	5.73 (2.50)	5.13 (2.37)	4.67 (2.27)	5.13 (2.37)	5.70	69.22
Emamectin Benzoate 5% SG	8.5	14.00 (3.81)	6.73 (2.69)	6.00 (2.55)	7.20 (2.77)	5.60 (2.47)	5.67 (2.48)	6.27 (2.60)	5.73 (2.50)	6.33 (2.61)	7.20 (2.77)	6.30	65.98
Untreated control	-	14.00 (3.81)	16.00 (4.06)	17.00 (4.18)	18.00 (4.30)	18.53 (4.36)	19.00 (4.41)	19.00 (4.41)	20.00 (4.53)	19.67 (4.49)	14.00 (4.48)	17.91	-
S.Em±	-	-	0.04	0.04	0.05	0.04	0.05	0.05	0.05	0.06	0.05	-	-
CD@5%	-	NS	0.12	0.13	0.14	0.13	0.16	0.15	0.14	0.19	0.16	-	-

DAS – Day After Spray, Figures in the parenthesis are square root $(\sqrt{x+0.5})$ transformed values, ROC – Reduction Over Control, NS – Non significant

Table 3: Efficacy of Cyantraniliprole 10.26 % OD against fruit borer, *Helicoverpa armigera* population in okra crop

Treatments	*Dose g a.i./ha*	*Avg. no. of larva/5 plants*										*Mean*	*% ROC*
		Pre-count	*First spray*			*Second spray*			*Third spray*				
			3 DAS	*7 DAS*	*10 DAS*	*3 DAS*	*7 DAS*	*10 DAS*	*3 DAS*	*7 DAS*	*10 DAS*		
Cyantraniliprole 10.26 % OD	30	1.27 (1.33)	0.97 (1.21)	1.40 (1.38)	1.77 (1.50)	1.30 (1.34)	1.30 (1.34)	1.47 (1.40)	1.03 (1.24)	1.13 (1.28)	1.23 (1.31)	1.29	46.30
Cyantraniliprole 10.26 % OD	60	1.33 (1.35)	0.63 (1.06)	0.90 (1.18)	1.33 (1.33)	0.70 (1.08)	0.97 (1.21)	1.10 (1.26)	0.87 (1.17)	1.00 (1.22)	1.13 (1.28)	0.96	60.34
Cyantraniliprole 10.26 % OD	90	1.30 (1.34)	0.00 (0.71)	0.27 (0.88)	1.30 (0.94)	0.00 (0.71)	0.27 (0.87)	0.47 (0.98)	0.00 (0.71)	0.23 (0.86)	0.30 (0.89)	0.32	90.74
Cyantraniliprole 10.26 % OD	120	1.37 (1.37)	0.00 (0.71)	0.23 (0.86)	1.37 (1.00)	0.00 (0.71)	0.27 (0.88)	0.43 (0.96)	0.00 (0.71)	0.17 (0.82)	0.23 (0.85)	0.30	91.98
Thiamethoxam 25% WG	25	1.27 (1.33)	0.90 (1.18)	1.40 (1.38)	1.27 (1.32)	1.30 (1.34)	1.37 (1.37)	1.60 (1.45)	1.13 (1.27)	1.30 (1.34)	1.40 (1.38)	1.30	43.21
Emamectin Benzoate 5% SG	8.5	1.27 (1.33)	0.70 (1.09)	0.80 (1.14)	1.27 (1.59)	1.10 (1.26)	1.17 (1.29)	1.30 (1.34)	0.87 (1.17)	1.07 (1.25)	1.23 (1.32)	1.06	56.17
Untreated control	-	1.30 (1.34)	1.63 (1.46)	1.90 (1.55)	1.30 (1.34)	2.20 (1.64)	2.30 (1.67)	2.47 (1.72)	2.70 (1.78)	3.13 (1.91)	3.23 (1.93)	2.32	-
S.Em±	-	-	0.02	0.02	0.03	0.03	0.04	0.05	0.03	0.02	0.04	-	-
CD@5%	-	NS	0.06	0.06	0.09	0.08	0.11	0.15	0.10	0.05	0.12	-	-

DAS – Day After Spray, Figures in the parenthesis are square root $(\sqrt{x+0.5})$ transformed values, ROC – Reduction Over Control, NS – Non significant

Table 4: Efficacy of Cyantraniliprole 10.26 % OD on per cent fruit damage caused by fruit borer, *Helicoverpa armigera* in okra crop

Treatments	*Dose g a.i./ha*	*Pre-count*	*First spray*			*Second spray*			*Third spray*			*Mean*	*% ROC*
			3 DAS	*7 DAS*	*10 DAS*	*3 DAS*	*7 DAS*	*10 DAS*	*3 DAS*	*7 DAS*	*10 DAS*		
Cyantraniliprole 10.26 % OD	30	29.70 (5.49)	16.67 (4.13)	14.58 (3.87)	15.93 (4.04)	15.28 (3.96)	13.43 (3.61)	15.28 (3.93)	14.91 (3.87)	14.66 (3.84)	16.20 (4.06)	15.22	52.33
Cyantraniliprole 10.26 % OD	60	26.59 (5.18)	11.13 (3.41)	9.38 (3.10)	10.72 (3.35)	10.21 (3.27)	8.44 (2.90)	10.03 (3.19)	9.88 (3.16)	9.75 (3.14)	11.54 (3.45)	10.12	68.31
Cyantraniliprole 10.26 % OD	90	27.62 (5.27)	6.94 (2.70)	5.19 (2.14)	6.94 (2.70)	6.69 (2.66)	5.03 (2.11)	6.69 (2.66)	6.54 (2.62)	6.44 (2.60)	8.20 (2.91)	6.52	79.58
Cyantraniliprole 10.26 % OD	120	27.78 (5.30)	6.72 (2.69)	4.34 (2.00)	6.43 (2.62)	6.19 (2.58)	4.76 (1.75)	6.98 (2.41)	5.79 (2.24)	5.66 (2.21)	7.21 (2.74)	6.01	81.18
Thiamethoxam 25% WG	25	28.19 (5.35)	17.57 (4.24)	15.72 (4.00)	17.57 (4.24)	16.93 (4.17)	13.51 (3.73)	15.18 (3.93)	15.00 (3.90)	14.55 (3.84)	16.21 (4.07)	15.80	50.52
Emamectin Benzoate 5% SG	8.5	28.33 (5.36)	11.03 (3.33)	9.27 (3.02)	10.23 (3.23)	9.95 (3.18)	8.81 (2.93)	10.66 (3.14)	10.51 (3.10)	10.44 (3.09)	11.52 (3.34)	10.27	67.84
Untreated control	-	27.29 (5.26)	30.79 (5.59)	30.79 (5.59)	30.99 (5.60)	31.16 (5.62)	32.75 (5.77)	34.60 (5.92)	32.24 (5.72)	31.24 (5.63)	32.83 (5.76)	31.93	-
S.Em±	-	-	0.25	0.34	0.24	0.25	0.56	0.52	0.49	0.50	0.37	-	-
CD@5%	-	NS	0.75	1.02	0.72	0.76	1.68	1.57	1.47	1.51	1.11	-	-

DAS – Day After Spray, Figures in the parenthesis are square root $(\sqrt{x+0.5})$ transformed values, ROC – Reduction Over Control, NS – Non significant

to notice at different days after the spray of insecticides. The data recorded after three sprays of insecticides depicted the lowest per cent of mean fruit damage (6.01 %) with the highest overall pest reduction over control (81.18 %) in cyantraniliprole 10.26 OD @120 g a.i./ha, which was found on par with cyantraniliprole 10.26 % OD @ 90 g a.i./ha achieving 6.52 % damage and 79.58 % pest reduction. Untreated control treatment recorded the highest per cent fruit damage (31.93 %) followed by thiamethoxam 25 WG @ 25 g a.i./ha (15.80 %), cyantraniliprole 10.26 OD @ 30 g a.i./ha (15.22 %), emamectin benzoate 5 SG @ 8.5 g a.i./ha (10.27 %) and cyantraniliprole 10.26 OD @ 60 g a.i./ha (10.12 %).

Shoot and fruit borer (*Earias vitella*)

Before spray, the larval population of shoot and fruit borer was non-significant among all the treatments and it ranged from 2.00 to 2.23 larva per 5 plants. Significant differences between the treatments started to notice after the imposition of the chemicals (Table 5). Significantly less larval population (0.17/5 plants) of shoot and fruit borer was recorded in cyantraniliprole 10.26 OD @120 g a.i./ha which was found on par (0.23/5 plants) with cyantraniliprole 10.26 % OD @90 g a.i./ha. The respective overall reduction of larval population over untreated control was 94.69 and 92.85 %. Untreated control treatment has recorded the highest mean larval population of shoot and fruit borer (3.21 larva/ 5 plants) followed by thiamethoxam 25 WG @ 25 g a.i./ha (1.91 larva/plant), cyantraniliprole 10.26 OD @ 30 g a.i./ha (1.61 larva/plant), emamectin benzoate 5 SG @ 8.5 g a.i./ha (1.21 larva/plant) and cyantraniliprole 10.26 OD @ 60 g a.i./ha (1.06 larva/plant)

The fruit damage (31.05 to 33.42 %) was non-significant among all the tested treatments before the spray. The per cent fruit damage started to notice significant differences among the treatments after the spray of the chemicals (Table 6). The data recorded after three sprays of insecticides depicted the lowest per cent of mean fruit damage (8.91 %) with the highest overall pest reduction over control (83.69 %) in cyantraniliprole 10.26 OD @120 g a.i./ha, which was found on par with cyantraniliprole 10.26 % OD @ 90 g a.i./ha attaining 9.13 % fruit damage and 82.83 % reduction. Untreated control treatment recorded the highest per cent fruit damage (37.76 %) followed by thiamethoxam 25 WG @ 25 g a.i./ha (14.38 %), cyantraniliprole 10.26 OD @ 30 g a.i./ha (14.12 %), emamectin benzoate 5 SG @ 8.5 g a.i./ha (12.60 %), and cyantraniliprole 10.26 OD @ 60 g a.i./ha (12.13 %). Here the respective pest reductions over control were 67.71, 68.40, 72.87 and 73.78 %.

Tobacco caterpillar (*Spodoptera litura*)

The data on larval population of tobacco caterpillar (Table 7) revealed non-significant differences before spraying and the population ranged from 2.53 to 2.80 larvae/5plants. Whereas, significant differences among the treatments was started to notice after the imposition of insecticides. The data recorded at different days after three sprays revealed the lowest mean larval population of tobacco caterpillar (0.18 larvae/5 plants) with highest overall per cent of pest reduction over control (94.95 %) in cyantraniliprole 10.26 OD @120 g a.i./ha, which was found on par with the treatment, cyantraniliprole 10.26 % OD @90 g a.i./ha having 0.25 larva/5 plants with 93.14 % pest reduction. The highest population of tobacco caterpillar (3.67 larvae/5 plants) was recorded in untreated control treatment, followed by other treatments like thiamethoxam 25 WG @ 25 g a.i./ha, cyantraniliprole 10.26 OD @ 30 g a.i./ha, emamectin benzoate 5 SG @ 8.5 g a.i./ha and cyantraniliprole 10.26 OD @ 60 g a.i./ha with larval population and reduction over control ranged from 1.74 to 1.08/5 plants and 52.67 to 70.43 %, respectively.

Effect of Cyantraniliprole 10.26 OD on yield of okra

Significant differences in the yield of okra were recorded (Table 8) .among the treatments over the untreated control. However, the significantly highest yield was recorded in cyantraniliprole 10.26 OD @120 g a.i./ha (10.90 t/ha) and it was on par with cyantraniliprole 10.26 OD @ 90 g a.i./ha (10.87 t/ha). However, the untreated check recorded relatively the lowest yield (5.40 t/ha), followed by thiamethoxam 25 WG @ 25 g a.i./ha

Table 5: Efficacy of Cyantraniliprole 10.26 % OD against Shoot and fruit borer, *Earias vitella* population in okra crop

Treatments	*Dose g a.i./ha*	*Pre-count*	*First spray*			*Second spray*			*Third spray*			*Mean*	*% ROC*
			3 DAS	*7 DAS*	*10 DAS*	*3 DAS*	*7 DAS*	*10 DAS*	*3 DAS*	*7 DAS*	*10 DAS*		
Cyantraniliprole 10.26 % OD	30	2.17 (1.63)	1.33 (1.35)	1.57 (1.44)	2.20 (1.64)	1.47 (1.40)	1.80 (1.51)	2.13 (1.62)	1.00 (1.22)	1.33 (1.35)	1.67 (1.47)	1.61	49.81
Cyantraniliprole 10.26 % OD	60	2.00 (1.58)	0.83 (1.15)	1.13 (1.28)	1.60 (1.45)	0.73 (1.11)	1.00 (1.22)	1.27 (1.33)	0.80 (1.14)	1.00 (1.22)	1.20 (1.30)	1.06	66.89
Cyantraniliprole 10.26 % OD	90	2.13 (1.62)	0.00 (0.71)	0.13 (0.79)	0.40 (0.94)	0.00 (0.71)	0.27 (0.87)	0.53 (1.01)	0.00 (0.71)	0.27 (0.87)	0.47 (0.98)	0.23	92.85
Cyantraniliprole 10.26 % OD	120	2.10 (1.61)	0.00 (0.71)	0.07 (0.75)	0.27 (0.87)	0.00 (0.71)	0.13 (0.79)	0.40 (0.94)	0.00 (0.71)	0.20 (0.84)	0.47 (0.98)	0.17	94.69
Thiamethoxam 25% WG	25	2.03 (1.59)	1.40 (1.38)	1.63 (1.46)	2.33 (1.68)	1.33 (1.35)	1.93 (1.56)	2.60 (1.35)	1.40 (1.38)	2.13 (1.62)	2.40 (1.70)	1.91	40.58
Emamectin Benzoate 5% SG	8.5	2.20 (1.65)	0.97 (1.21)	1.13 (1.27)	1.80 (1.52)	1.00 (1.22)	1.20 (1.30)	1.330 (1.97)	0.67 (1.08)	1.27 (1.33)	1.53 (1.43)	1.21	62.27
Untreated control	-	2.17 (1.63)	2.67 (1.78)	3.00 (1.87)	3.40 (1.97)	3.27 (1.94)	3.13 (1.91)	3.40 (2.45)	3.33 (1.96)	2.93 (1.85)	3.80 (2.07	3.21	-
S.Em±	-	-	0.03	0.03	0.03	0.04	0.04	0.06	0.04	0.05	0.03	-	-
CD@5%	-	NS	0.09	0.08	0.10	0.11	0.13	0.17	0.11	0.14	0.08	-	-

DAS – Day After Spray, Figures in the parenthesis are square root $(\sqrt{x+0.5})$ transformed values, ROC – Reduction Over Control, NS – Non significant

Table 6: Efficacy of Cyantraniliprole 10.26 % OD against percent fruit damage caused by Shoot and fruit borer, *Earias vitella* in okra crop

Treatments	*Dose g a.i./ha*	*Pre-count*	*First spray*			*Second spray*			*Third spray*			*Mean*	*% ROC*
			3 DAS	*7 DAS*	*10 DAS*	*3 DAS*	*7 DAS*	*10 DAS*	*3 DAS*	*7 DAS*	*10 DAS*		
Cyantraniliprole 10.26 % OD	30	32.48 (5.74)	11.35 (3.40)	12.40 (3.56)	13.45 (3.70)	10.40 (3.29)	10.71 (3.34)	12.46 (3.58)	11.57 (3.47)	12.68 (3.61)	13.72 (3.76)	14.12	68.40
Cyantraniliprole 10.26 % OD	60	31.05 (5.61)	8.91 (2.99)	9.88 (3.14)	11.06 (3.37)	8.26 (2.92)	8.49 (2.95)	10.07 (3.24)	9.75 (3.17)	10.86 (3.31)	12.95 (3.65)	12.13	73.78
Cyantraniliprole 10.26 % OD	90	32.26 (5.70)	6.18 (2.57)	7.42 (2.76)	9.40 (3.14)	4.72 (2.26)	4.81 (2.28)	6.00 (2.53)	5.12 (2.35)	6.10 (2.53)	9.33 (3.10)	9.13	82.83
Cyantraniliprole 10.26 % OD	120	32.94 (5.76)	6.00 (2.52)	7.31 (2.71)	8.19 (2.90)	4.18 (2.16)	4.30 (2.19)	5.63 (2.45)	5.10 (2.35)	6.05 (2.52)	9.38 (3.11)	8.91	83.69
Thiamethoxam 25% WG	25	32.64 (5.76)	10.75 (3.35)	10.92 (3.34)	12.03 (3.52)	10.75 (3.35)	11.02 (3.39)	12.35 (3.57)	13.34 (3.67)	14.45 (3.79)	15.53 (3.95)	14.38	67.71
Emamectin Benzoate 5% SG	8.5	32.64 (5.76)	9.05 (3.07)	10.24 (3.27)	12.42 (3.58)	8.71 (3.02)	8.97 (3.06)	10.30 (3.26)	10.18 (3.23)	11.16 (3.35)	12.33 (3.53)	12.60	72.87
Untreated control	-	33.42 (5.82)	34.24 (5.87)	36.16 (5.98)	37.67 (6.01)	37.59 (6.15)	38.58 (6.23)	38.58 (6.23)	39.17 (6.23)	40.51 (6.32)	41.66 (6.40)	37.76	-
S.Em±	-	-	0.32	0.43	0.39	0.27	0.27	0.27	0.39	0.50	0.43	-	-
CD@5%	-	NS	0.96	1.28	1.16	0.82	0.81	0.82	1.18	1.50	1.30	-	-

DAS – Day After Spray, Figures in the parenthesis are square root $(\sqrt{x+0.5})$ transformed values, ROC – Reduction Over Control, NS – Non significant

Table 7: Efficacy of Cyantraniliprole 10.26 % OD against Tobacco caterpillar, *Spodoptera litura* population in okra crop

Treatments	Dose g a.i./ha	Pre-count	First spray			Second spray			Third spray			Mean	% ROC
			3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS		
Cyantraniliprole 10.26 % OD	30	2.53 (1.74)	1.47 (1.40)	1.63 (1.46)	2.27 (1.66)	1.20 (1.30)	1.73 (1.49)	2.00 (1.58)	1.07 (1.25)	1.27 (1.33)	1.60 (1.45)	1.58	56.91
Cyantraniliprole 10.26 % OD	60	2.60 (1.76)	0.83 (1.15)	1.20 (1.30)	1.53 (1.42)	0.73 (1.10)	1.07 (1.25)	1.33 (1.35)	0.80 (1.14)	1.07 (1.25)	1.20 (1.30)	1.08	70.43
Cyantraniliprole 10.26 % OD	90	2.70 (1.79)	0.20 (0.83)	0.27 (0.87)	0.40 (0.94)	0.07 (0.75)	0.27 (0.87)	0.40 (0.94)	0.07 (0.75)	0.20 (0.84)	0.40 (0.94)	0.25	93.14
Cyantraniliprole 10.26 % OD	120	2.53 (1.74)	0.13 (0.79)	0.20 (0.84)	0.33 (0.91)	0.00 (0.71)	0.20 (0.83)	0.27 (0.87)	0.00 (0.71)	0.20 (0.84)	0.33 (0.91)	0.18	94.95
Thiamethoxam 25% WG	25	2.60 (1.76)	1.53 (1.42)	1.70 (1.48)	1.87 (1.54)	1.33 (1.35)	1.47 (1.40)	2.00 (1.58)	1.33 (1.35)	2.07 (1.60)	2.33 (1.68)	1.74	52.67
Emamectin Benzoate 5% SG	8.5	2.53 (1.74)	0.97 (1.21)	1.13 (1.27)	1.47 (1.40)	0.93 (1.19)	1.27 (1.33)	1.53 (1.42)	0.80 (1.14)	1.33 (1.35)	1.47 (1.40)	1.21	67.00
Untreated control	-	2.80 (1.81)	3.20 (1.92)	3.33 (1.96)	3.47 (1.99)	3.60 (2.02)	3.80 (2.07)	3.87 (2.09)	4.00 (2.12)	3.87 (2.09)	3.93 (2.11)	3.67	-
S.Em±	-	-	0.05	0.03	0.04	0.07	0.06	0.04	0.03	0.03	0.04	-	-
CD@5%	-	NS	0.14	0.09	0.13	0.22	0.17	0.13	0.09	0.10	0.13	-	-

DAS – Day After Spray, Figures in the parenthesis are square root $(\sqrt{x+0.5})$ transformed values, ROC – Reduction Over Control, NS – Non significant

Table 8: Effects of Cyantraniliprole 10.26 % OD on yield of okra

Treatments	*Dose g a.i./ha*	*Yield (t/ha)*
Cyantraniliprole 10.26 % OD	30	7.17
Cyantraniliprole 10.26 % OD	60	8.00
Cyantraniliprole 10.26 % OD	90	10.87
Cyantraniliprole 10.26 % OD	120	10.90
Thiamethoxam 25% WG	25	6.83
Emamectin Benzoate 5% SG	8.5	7.80
Untreated control	-	5.40
S.Em±	-	0.44
CD@5%	-	1.30

(6.83 t/ha), cyantraniliprole 10.26 OD @ 30 g a.i./ha (7.17 t/ha), emamectin benzoate 5 SG @ 8.5 g a.i./ha (7.80 t/ha) and cyantraniliprole 10.26 OD @ 60 g a.i./ha (8.00 t/ha).

Efficacy of Cyantraniliprole 10.26 OD against major sucking and lepidopteran insects of cabbage

Sucking insects

Aphids (*Brevicoryne brassicae* and *Lipaphis erysimi*)

The pest population before spray was uniformly established in the experimental plots as there was no significant difference in the population. The data recorded for surviving mean population of cabbage aphid (*Brevicoryne brassicae*) (Table 9) and mustard aphid (*Lipaphis erysimi*) (Table 10) indicated significant differences in their population at 3, 7 and 10 days after sprays. All the insecticide treatments recorded significantly lowered the pest population than untreated control (UTC).

The treatment with cyantraniliprole 10.26 OD @ 75 g a.i./ha showed excellent efficacy against *Brevicoryne brassicae* with 87.50 % reduction in population over UTC at 10 days after 3rd application. Here, the next superior at par treatment was cyantraniliprole 10.26 % OD @ 60 g a.i./ha, which recorded 86.25 % reduction of pest population over UTC. The mean number of Cabbage aphid population in untreated control at 10 days after 3rd application was 26.67/ plant, followed by chlorfluazuron 5.40 EC @ 75 g a.i./ha (11.00/plant), cyantraniliprole 10.26 OD @ 30 g a.i./ha (8.00/plant), cyantraniliprole 10.26 OD @ 45 g a.i./ha (6.33/plant) and acetamiprid 20 SP @ 15 g a.i./ha (5.00/plant). Here the respective reductions of aphid population over control were 58.76, 70.00, 76.25 and 81.25 %.

Similar trend was also observed against another aphid species, *Lipaphis erysimi.* cyantraniliprole 10.26 OD @ 75 g a.i./ha recorded 3.47 aphids/plant with the highest mortality (87.00 %) over UTC at 10 days after 3rd application. The next superior treatment was cyantraniliprole 10.26 % OD @ 60 g a.i./ha, having 3.53 aphids/plant with 86.75 % reduction over UTC. Both the treatments were statistically at par with each other. The mean number of mustard aphid's population per plant in UTC at 10 days after 3rd application was 26.67, followed by 10.67 (chlorfluazuron 5.40 EC @ 75 g a.i./ha), 8.33 (cyantraniliprole 10.26 OD @ 30 g a.i./ha), 6.53 (cyantraniliprole 10.26 OD @ 45 g a.i./ha) and 5.33 (acetamiprid 20 SP @ 15 g a.i./ha). The respective reductions of pest over UTC were 60.00, 68.75, 75.50 and 80.00 %.

Lepidopteran insects

The pest population before spray was uniformly established in the experimental plots as there was no significant difference in the population. The data was recorded for surviving mean larval population of diamond Back moth (*Plutella xylostella*) (Table 11) and tobacco caterpillar (*Spodoptera litura)* (Table 12). Here, the differences in their larval population were significant at 3, 7 and 10 days after sprays. All the insecticide treatments recorded significantly lower larval population than untreated control.

Diamond back moth (DBM) (*Plutella xylostella)*

The treatment with cyantraniliprole 10.26 OD @ 75 g a.i./ha showed excellent efficacy against *Plutella xylostella* with 90.55 % reduction of DBM larval population (2.07/5 plants) over UTC at 10 days after 3rd application. The next superior treatment was cyantraniliprole 10.26 OD @ 60 g a.i./ha which recorded 2.13 larva/5 plants with 90.25 % reduction of pest over UTC. Both these treatments found statistically at par. The mean number of larval population per 5 plant in UTC at 10 days after 3rd application was 21.87,

Table 9: Efficacy of Cyantraniliprole 10.26 % OD against *Brevicoryne brassicae* on cabbage

Treatments	*Dose*	*Population of Brevicoryne brassicae/ Plant*										*% ROC*
	g a.i./ha	*Before spray*	*1st spray*			*2nd spray*			*3rd spray*			
			3 DAA	*7 DAA*	*10 DAA*	*3 DAA*	*7 DAA*	*10 DAA*	*3 DAA*	*7 DAA*	*10 DAA*	
Cyantraniliprole 10.26 % OD	30	22.33 (4.78)	8.87 (3.06)	8.47 (2.99)	9.67 (3.18)	11.00 (3.39)	8.00 (3.08)	12.33 (3.57)	8.20 (2.95)	7.33 (2.80)	8.00 (2.91)	70.00
Cyantraniliprole 10.26 % OD	45	22.00 (4.74)	6.33 (2.61)	6.27 (2.59)	7.33 (2.79)	8.00 (2.91)	4.67 (2.74)	8.00 (2.91)	5.20 (2.38)	5.33 (2.33)	6.33 (2.61)	76.25
Cyantraniliprole 10.26 % OD	60	22.00 (4.74)	2.80 (1.82)	2.47 (1.72)	3.27 (1.94)	5.00 (2.32)	2.00 (2.22)	5.00 (2.34)	4.47 (2.23)	4.67 (2.11)	3.67 (2.02)	86.25
Cyantraniliprole 10.26 % OD	75	22.33 (4.78)	1.80 (1.52)	1.73 (1.48)	3.00 (1.87)	5.00 (2.34)	1.67 (1.72)	3.53 (2.01)	3.00 (1.86)	2.67 (1.59)	3.33 (1.95)	87.50
Chlorfluazuron 05.40% EC	75	22.10 (4.76)	12.33 (3.58)	12.33 (3.57)	15.00 (3.93)	16.00 (4.06)	12.67 (3.67)	14.97 (3.89	12.33 (3.58)	14.00 (3.55)	11.00 (3.38)	58.76
Acetamiprid 20% SP	15	20.93 (4.63)	5.20 (2.38)	5.13 (2.37)	6.00 (2.54)	7.33 (2.80)	4.00 (2.65)	6.20 (2.59)	5.00 (2.34)	5.00 (2.26)	5.00 (2.35)	81.25
Untreated control	-	21.93 (4.74)	24.00 (4.95)	26.67 (5.21)	27.00 (5.24)	29.00 (5.43)	25.67 (5.37)	31.67 (5.67)	29.00 (5.43	26.67 (5.61)	26.67 (5.20)	-
S.Em.±		-	0.10	0.13	5.33	0.13	0.11	0.07	0.12	0.11	0.16	-
C.D. at 5%		NS	0.29	0.39	0.33	0.39	0.33	0.22	0.36	0.32	0.47	-

Figures in parenthesis are ($\sqrt{x+0.5}$) transformed values; DAA - days after application; NS- Non significant; % ROC - Reduction over control @ 10 days after 3rd spray

Table 10: Efficacy of Cyantraniliprole 10.26 % OD against *Lipaphis erysimi* on cabbage

Treatments		*Population of Lipaphis erysimi / Plant*										*% ROC*
	g a.i./ha	*Before spray*	*1st spray*			*2nd spray*			*3rd spray*			
			3 DAA	*7 DAA*	*10 DAA*	*3 DAA*	*7 DAA*	*10 DAA*	*3 DAA*	*7 DAA*	*10 DAA*	
Cyantraniliprole 10.26 % OD	30	32.33 (5.73)	9.53 (3.17)	9.20 (3.21)	11.00 (3.39)	9.67 (3.19)	9.13 (3.10)	11.00 (3.39)	8.67 (3.02)	7.40 (2.81)	8.33 (2.96)	68.75
Cyantraniliprole 10.26 % OD	45	31.67 (5.67)	6.67 (2.68)	6.27 (2.51)	7.67 (2.85)	7.67 (2.85)	6.80 (2.70)	7.67 (2.85)	6.33 (2.60)	4.70 (2.28)	6.53 (2.64)	75.50
Cyantraniliprole 10.26 % OD	60	32.33 (5.73)	3.40 (1.97)	3.07 (1.91)	3.60 (2.02)	3.67 (2.04)	3.00 (1.87)	3.67 (2.03)	2.80 (1.80)	2.00 (1.56)	3.53 (2.00)	86.75
Cyantraniliprole 10.26 % OD	75	33.67 (5.85)	2.13 (1.62)	1.80 (1.82)	3.13 (1.90)	3.60 (2.02)	2.67 (1.78)	3.20 (1.92)	2.47	1.80 (1.51)	3.47 (1.99)	87.00
Chlorfluazuron 05.40% EC	75	33.27 (5.81)	12.67 (3.62)	12.00 (3.53)	15.33 (3.97)	13.00 (3.67)	12.53 (3.60)	14.00 (3.81)	11.67 (3.49)	11.00 (3.39)	10.67 (3.33)	60.00
Acetamiprid 20% SP	15	32.73 (5.760)	5.13 (2.37)	4.93 (2.33)	6.33 (2.61)	6.67 (2.68)	6.20 (2.59)	6.33 (2.61)	4.67 (2.27)	4.33 (2.20)	5.33 (2.41)	80.00
Untreated control	-	34.00 (5.87)	35.00 (5.96)	34.33 (5.90)	27.33 (5.28)	29.33 (5.46)	29.67 (5.49)	30.67 (5.58)	31.33 (5.64)	31.67 (5.67)	26.67 (5.20)	-
S.Em.±		-	0.07	0.13	0.09	0.11	0.09	0.08	0.12	0.11	0.18	-
C.D. at 5%		NS	0.20	0.38	0.26	0.34	0.26	0.24	0.18	0.33	0.55	-

Figures in parenthesis are ($\sqrt{x+0.5}$) transformed values; DAA - days after application; NS- Non significant; % ROC - Reduction over control @ 10 days after 3rd spray

Table 11: Efficacy of Cyantraniliprole 10.26 % OD against *Plutella xylostella*on cabbage

Treatments	*Dose*	*Population of Plutella xylostella/ 5 Plants*										*% ROC*
	g a.i./ha	*Before spray*	*1st spray*			*2nd spray*			*3rd spray*			
			3 DAA	*7 DAA*	*10 DAA*	*3 DAA*	*7 DAA*	*10 DAA*	*3 DAA*	*7 DAA*	*10 DAA*	
Cyantraniliprole 10.26 % OD	30	13.33 (2.85)	7.00 (2.73)	6.67 (2.67)	7.80 (2.87)	6.87 (2.71)	6.00 (2.54)	8.00 (2.91)	6.00 (2.54)	5.00 (2.34)	6.33 (2.60)	71.04
Cyantraniliprole 10.26 % OD	45	13.00 (2.93)	6.40 (2.63)	6.27 (2.60)	7.00 (2.74)	5.47 (2.44)	5.40 (2.43)	7.07 (2.75)	5.67 (2.48)	4.47 (2.23)	5.40 (2.43)	75.31
Cyantraniliprole 10.26 % OD	60	14.00 (3.29)	3.53 (2.00)	3.33 (1.94)	4.00 (2.11)	2.93 (1.85)	2.67 (1.77	3.67 (2.04)	2.53 (1.74)	1.87 (1.53)	2.13 (1.62)	90.25
Cyantraniliprole 10.26 % OD	75	13.00 (3.29)	3.20 (1.92)	3.13 (1.89)	3.93 (2.10)	2.87 (1.83)	2.60 (1.76)	3.40 (1.97)	2.40 (1.70	1.80 (1.51)	2.07 (1.60	90.55
Chlorfluazuron 05.40% EC	75	13.00 (3.29)	7.00 (2.73)	6.53 (2.75)	7.07 (2.38)	6.33 (2.60)	6.13 (2.57)	7.80 (2.88)	6.00 (2.54)	5.73 (2.49)	5.93 (2.53)	72.87
Acetamiprid 20% SP	15	13.67 (3.40)	10.00 (3.24)	10.07 (3.35)	10.73 (2.83)	9.00 (3.08)	8.80 (3.05)	10.20 (3.27)	8.47 (2.99)	8.00 (2.91)	8.40 (2.98	61.59
Untreated control	-	13.33 (3.55)	11.67 (14.67)	16.00 (4.18)	17.00 (3.65)	18.67 (4.38)	19.67 (4.49)	20.67 (4.60)	21.33 (4.67)	21.00 (4.64)	21.87 (4.73)	-
S.Em.±		-	0.10	0.13	0.13	0.09	0.10	0.09	0.10	0.11	0.09	-
C.D. at 5%		NS	0.31	0.40	0.39	0.28	0.29	0.26	0.30	0.32	0.26	-

Figures in parenthesis are $(\sqrt{x+0.5})$ transformed values; DAA - days after application; NS- Non significant; % ROC - Reduction over control @ 10 days after 3rd spray

Table 12: Efficacy of Cyantraniliprole 10.26 % OD against *Spodoptera litura* on cabbage.

Treatments	**Dose**	**Population of *Plutellax ylostella*/ 5 Plants**										**% ROC**
		Before spray	1st spray			2nd spray			3rd spray			
			3 DAA	7 DAA	10 DAA	3 DAA	7 DAA	**10 DAA**	**3 DAA**	**7 DAA**	**10 DAA**	
Cyantraniliprole 10.26 % OD	30	4.00 (2.11)	2.93 (1.85)	2.47 (1.72)	2.67 (1.77)	2.00 (1.58)	1.80 (1.52)	2.13 (1.62)	1.67 (1.47)	1.47 (1.40)	2.93 (1.85)	55.08
Cyantraniliprole 10.26 % OD	45	4.20 (2.16)	2.47 (1.72)	1.87 (1.52)	2.27 (1.66)	1.33 (1.35)	1.13 (1.27)	1.47 (1.40)	1.07 (1.25)	0.87 (1.17)	1.87 (1.53)	71.41
Cyantraniliprole 10.26 % OD	60	4.47 (2.22)	1.00 (1.22)	0.40 (0.94)	0.80 (1.14)	0.33 (0.91)	0.20 (0.83)	0.40 (0.94)	0.13 (0.79)	0.07 (0.75)	0.73 (1.11)	88.77
Cyantraniliprole 10.26 % OD	75	4.33 (2.20)	0.87 (1.17)	0.20 (0.83)	0.60 (1.05)	0.20 (0.83)	0.13 (0.79)	0.40 (0.94)	0.07 (0.75)	0.00 (0.71)	0.67 (1.07)	89.79
Chlorfluazuron 05.40% EC	75	4.67 (2.27)	2.47 (1.72)	1.93 (1.56)	2.80 (1.82)	1.87 (1.54)	1.60 (1.45)	1.93 (1.56)	1.40 (1.38)	0.80 (1.14)	1.93 (1.56)	70.39
Acetamiprid 20% SP	15	4.33 (2.19)	3.07 (1.89)	2.20 (1.64)	3.27 (1.94)	2.73 (1.80)	2.13 (1.62)	2.07 (1.60)	1.53 (1.42)	1.13 (1.27)	2.33 (1.68)	64.27
Untreated control	-	4.60 (2.25)	5.20 (2.38)	5.53 (2.45)	6.07 (2.56)	5.53 (2.45)	6.07 (2.56)	6.20 (2.59)	6.00 (2.55)	5.93 (2.54)	6.53 (2.65)	-
S.Em.±		-	0.13	0.07	0.04	0.05	0.05	0.04	0.07	0.04	0.07	-
C.D. at 5%		NS	0.23	0.20	0.13	0.15	0.14	0.13	0.20	0.13	0.20	-

Figures in parenthesis are $(\sqrt{x+0.5})$ transformed values; DAA - days after application; NS- Non significant; % ROC - Reduction over control @ 10 days after 3rd spray

Table 13: Effect of Cyantraniliprole 10.26 % OD on yield of cabbage

Treatments	*Dose g a.i./ha*	*Yield (t/ha)*
Cyantraniliprole 10.26 % OD	30	44.33
Cyantraniliprole 10.26 % OD	45	52.32
Cyantraniliprole 10.26 % OD	60	61.33
Cyantraniliprole 10.26 % OD	75	61.67
Chlorfluazuron 05.40% EC	75	51.67
Acetamiprid 20% SP	15	50.67
Untreated control	-	34.67
S.Em.±		1.46
C.D. at 5%		4.37

followed by 8.40 (acetamiprid 20 SP @ 15 g a.i./ha), 6.33 (cyantraniliprole 10.26 OD @ 30 g a.i./ha), 5.93 (chlorfluazuron 5.40 EC @ 75 g a.i./ha), and 5.40 (cyantraniliprole 10.26 OD @ 45 g a.i./ha).

Tobacco caterpillar (*Spodoptera litura*)

The same trend was also observed in controlling *Spodoptera litura*. Cyantraniliprole 10.26 OD @ 75 g a.i./ha recorded 0.67 larva/5 plants resulting the highest larval mortality (89.79 %) over UTC at 10 days after 3rd application. The next superior treatment was cyantraniliprole 10.26 OD @ 60 g a.i./ha, which recorded 0.73 larva/5 plants with 88.78 % larval reduction over UTC. Cyantraniliprole 10.26 OD @ 75 g a.i./ha statistically found similar with cyantraniliprole 10.26 OD @ 60 g a.i./ha. The mean larval population per 5 plants in UTC was 6.53, followed by 2.93 (cyantraniliprole 10.26 OD @ 30 g a.i./ha), 2.33 (acetamiprid 20 SP @ 15 g a.i./ha), 1.93 (chlorfluazuron 5.40 EC @ 75 g a.i./ha) and 1.87 (cyantraniliprole 10.26 OD @ 45 g a.i./ha) at 10 days after 3rd application. The respective reductions in larval population over UTC were 55.08, 64.27, 70.39 and 71.41 % at 10 days after 3rd application.

Effect of Cyantraniliprole 10.26 OD on yield of cabbage

All the treatments showed significantly higher yield than untreated control (Table 13). Maximum cabbage yield (61.67 t/ha) was recorded with the application of cyantraniliprole 10.26 OD @ 75 g a.i./ha, which was at par with cyantraniliprole 10.26 % OD @ 60 g a.i./ha (61.33 t/ha). Untreated control recorded only 34.67 t/ha, followed by cyantraniliprole 10.26 OD @ 30 g a.i./ha (44.33 t/ha), acetamiprid 20 SP @ 15 g a.i./ha (50.67 t/ha), chlorfluazuron 5.40 EC @ 75 g a.i./ha (51.67 t/ha) and cyantraniliprole 10.26 OD @ 45 g a.i./ha (52.32 t/ha)

DISCUSSION

Cyantraniliprole is a third generation anthranilic diamide insecticide with a mode of action (ryanodine receptor modulator) similar to chlorantraniliprole and flubendiamide. It has systemic activity with some translaminar movement and is effective against lepidopteran (larva) and sucking insects. The anthranillic diamide insecticide group possesses anti-feedant properties that differ between chemicals of this group and insects (Gonzales-Coloma *et al*., 1999) which might be the reason of record of low population of pests. In this connection, the present study results have direct or indirect confirmations from the following previous works.

Considering the significant bio-efficacy and yield, cyantraniliprole @ 90 g a.i./ha was recommended for effective control of sucking pests in cotton ecosystem (Patel *et al*., 2014; Karthik *et al.*, 2017), that strongly support the present findings obtained against *Aphis gossypii* and *Bemisia tabaci* on okra.

Effectiveness of cyantraniliprole was reported against whitefly on okra (Patel and Kher, 2012a) and other crops like brinjal (Patel and Kher, 2012b), tomato (Patel *et al*., 2011; Govindappa *et al*., 2013), cotton (Patel *et al*., 2014) and gherkins (Balikai and Mallapur, 2015).

Thara *et al*. (2019) reported 69 to 81.76 % larval population reduction of *Helicoverpa armigera* over control in okra with cyantraniliprole 10.26 OD @ 1.80 ml/l of water and fruit damage reduction varied from 35.36 to 65.08 % for the same. But, comparatively greater efficacy in present findings might be due to variations in respect of pest susceptibility, season, climate etc. However, both the lethal and sublethal effects of cyantraniliprole suppressed *H. assulta* population growth in tobacco by reducing the insect's survival, development and reproduction (Dong *et al*., 2017). The treatment of cyantraniliprole 10 OD @ 60 g a.i./ha provided excellent protection against *H. armigera* in potato (Lodaya *et al*. (2017)).

Information is scanty regarding effect of cyantraniliprole against *Earias vitella* on okra, although work has done on cotton. cyantraniliprole 10 OD @ 90 g a.i./ha resulted lowest per cent bud and boll damage by *Earias vittella* (Patel *et al*., 2014).

As per present observation cyantraniliprole was most effective in reducing *S. litura* population in okra and cabbage, which is in line of work done by Yadav *et al.* (2012) on grapes.

The present findings related to pest management of cabbage are in full agreement with Shalu and Math (2017). They observed this insecticide @ 60 g a.i./ha as broad spectrum and quite effective to manage both sucking (*B. Brassicae* and *L. Erysimi*) and lepidopteran (*P. xylostella* and *S. Litura*) insects with higher marketable cabbage heads. Different species of aphids in cabbage, *B. Brassicae* and *L. erysimi* were highly susceptible to cyantraniliprole @ 60 g a.i./ha and recorded the highest mortality at 80 and 86 % respectively. The same also resulted 100 % mortality against third instar *P. xyllostela* at 48 hours after treatment (Kodandaram *et al*., 2017). Stansly and Kostyk (2012) reported a significant decrease in the number of larvae and damage of the *P. xylostella* in a cauliflower crop using foliar applications of cyantraniliprole.

Cyantraniliprole as the third generation diamide insecticide is the first one that has activity on both chewing and sucking insect pests. This new molecule will be crucial for strengthening integrated pest management (IPM) and remain an effective insecticide partner for rotation in insecticide resistance management (IRM) programs in India. Based on the present investigation, it can be concluded that cyantraniliprole 10.26 OD at 90-120 g a.i./ha can be recommended to control aphids (*Aphis gossypii)*, white fly (*Bemisia tabaci)*, fruit borer (*Helicoverpa armigera)*, shoot and fruit borer (*Earias vitella)* and tobacco caterpillar (*Spodoptera litura)* in okra crop. Whereas, the same insecticide at 60 to 75 g a.i./ha was found to be very effective in reducing the major lepidopteran (*Plutella xylostella* and *Spodoptera litura*) and sucking insect pests (*Brevicoryne brassicae* and *Myzus persicae*) of cabbage.

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