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RESEARCH NOTE

Field efficacy of some newer insecticides along with biopesticides against major insect pests in broccoli

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ABSTRACT: An experiment was conducted to test the efficacy of certain new insecticides and biopesticides against major pests of broccoli at College of Agriculture, Rajendranagar, Hyderabad, India. There were nine treatments *viz*., acetamiprid 20% SP @ 0.2 g/L, *Bacillus thuringiensis* subsp. *kurstaki* @ 2 g/L, *Beauveria bassiana* @ 5 g/L, cyantraniliprole 10.26% OD @ 1.2 ml/L, chlorantraniliprole 18.50% SC @ 0.3 ml/L, diafenthiuron 50% WP @ 1.2 g/L, emamectin benzoate 5% SG @ 0.4 g/L, fipronil 5% SC @ 2 ml/L and *Metarhizium anisopliae* @ 5 g/L along with untreated control replicated thrice. The treatment cyantraniliprole 10.26% OD @ 1.2 ml/L was the most effective in management of *Plutella xylostella*, *Crocidolomia pavonana* and *Spodoptera litura* population followed by chlorantraniliprole 18.50% SC @ 0.3 ml/L and emamectin benzoate 5% SG @ 0.4 g/L. In case of *Myzus persicae*, acetamiprid 20% SP @ 0.2 g/L proved to be the most effective treatment showing maximum reduction in *M. persicae* population followed by cyantraniliprole 10.26% OD @ 1.2 ml/L and chlorantraniliprole 18.50% SC @ 0.3 ml/L.

Keywords: Aphid, acetamiprid, broccoli, chlorantraniliprole, cyantraniliprole, diamondback moth

Broccoli (*Brassica oleracea* L. var. *italica*) is a popular exotic vegetable with rich source of potassium, phosphorus, sulfur, and magnesium. Anticancer and antioxidant properties are also found in broccoli (Podsedek, 2007). Broccoli, which originated in the Mediterranean region, is widely grown in China, the USA, Spain, Mexico, India, and Italy. In India, it is cultivated in Uttar Pradesh, Himachal Pradesh, and the hilly areas of the Nilgiri Hills, Jammu and Kashmir, and the northern plains. The productivity of broccoli is influenced by many factors, of which insect pests such as lepidopterans and aphids are the most important. Farmers resort to repeated sprays of multiple pesticides to manage pests. However, the repeated use of conventional pesticides threatens the environment and natural enemies, and also causes problems of insecticide resistance. As completely doing away with chemical pesticides is not feasible, especially when insect pests load is high, using pesticides that are more selective and effective is imperative to minimize the damage (Jemimah *et al*., 2021). Hence, the present study was undertaken to evaluate some newer insecticides and biopesticides which will be more effective and have less impact on the environment and human health.

The present experiment was conducted at Rajendranagar, Hyderabad during *rabi* 2022-23 to study the efficacy of different insecticides and biopesticides against major insect pests infesting broccoli (Shishir F1 hybrid; Known-you seed). The experiment was laid out in randomized block design with 10 treatments including control replicated thrice with an individual plot size of 20 m^2 (5 m x 4 m). All the insecticides and biopesticides selected were applied as per the recommended dosages as foliar spray. Two sprayings were given during the crop period using a power sprayer at an interval of 15 days by initiating the first spray when the pest reached ETL. The observations on major insect pests were recorded one day before spraying as pretreatment counts and post treatment counts were recorded on 3rd, 5th and 7th day after spraying. Population of *Myzus persicae* (Sulzer) was recorded from 3 leaves *viz*., each one from top, middle and bottom plant canopy and represented as numbers per leaf per plant. The population of lepidopterans *i.e*., *Plutella xylostella* (Linnaeus), *Crocidolomia pavonana* (Fabricius) and *Spodoptera litura* (Fabricius) were recorded as larval counts and represented as numbers per plant. The observations were taken from 5 randomly selected plants in each plot and represented as numbers per plant.The mean population data obtained from different treatments was transformed into square root values before analysis. The modified data was then subjected to an analysis of variance (ANOVA). To differentiate the means of treatments that showed significant differences ($P < 0.05$), Duncan's Multiple Range Test (DMRT) was applied.The level of significance was fixed at $\alpha = 0.05$. All these statistical procedures were conducted utilizing WASP software.

The data regarding efficacy of different insecticides and biopesticides against major insect pests infesting broccoli after first and second spray are presented in table 1.

Diamondback moth (*Plutella xylostella*)

After 1st spray, a significantly less number of *P*. *xylostella* larvae were recorded by cyantraniliprole 10.26% OD @ 1.2 ml/L (0.76 larvae/plant) followed by chlorantraniliprole 18.50% SC @ 0.3 ml/L (1.11 larvae/plant), emamectin benzoate 5% SG @ 0.4 g/L (1.42 larvae/plant) and *Bacillus thuringiensis* subsp. *kurstaki* @ 2 g/L (2.40 larvae/plant). The plots treated with *Beauveria bassiana* @ 5 g/L (2.82 larvae/plant), acetamiprid 20% SP @ 0.2 g/L (2.96 larvae/plant) and diafenthiuron 50% WP @ 1.2 g/L (2.96 larvae/plant) were statistically on par with each other. Fipronil 5% SC @ 2 ml/L treated plots had 3.40 larvae/plant statistically equivalent in effectiveness with *Metarhizium anisopliae* @ 5 g/L (3.44 larvae/plant). After 2nd spray,the treatment cyantraniliprole 10.26% OD @ 1.2 ml/L recorded lowest mean population of *P*. *xylostella* larvae (0.51 larvae/plant) followed by chlorantraniliprole 18.50% SC @ 0.3 ml/L (0.84 larvae/plant), emamectin benzoate 5% SG @ 0.4 g/L (1.24 larvae/plant), *Bacillus thuringiensis* subsp. *kurstaki* @ 2 g/L (1.76 larvae/plant) and *Beauveria bassiana* @ 5 g/L (1.92 larvae/plant) (both on par with each other).The plots treated with acetamiprid 20% SP @ 0.2 g/L (2.24 larvae/plant), diafenthiuron 50% WP @ 1.2 g/L (2.40 larvae/plant), fipronil 5% SC @ 2 ml/L (2.44 larvae/plant) and *Metarhizium anisopliae* @ 5 g/L (2.51 larvae/plant) were statistically at par in effectiveness. All treatments showed superiority over untreated control where 4.22 larvae/plant was noted. These findings are in concurrence with Chowdary and Sharma (2019), who reported 81.02 per cent reduction in *P*. *xylostella* larval population on cabbage sprayed with chlorantraniliprole @ 10 g a.i./ha. Similarly, Beena and Selvi (2022) reported 77-99.5 per cent larval reduction by spraying with cyantraniliprole 10.26% OD @ 60 g a.i./ha on cauliflower.

Leaf webber (*Crocidolomia pavonana*)

After 1st spray, the treatment cyantraniliprole 10.26% OD @ 1.2 ml/L recorded significantly lower population of *C*. *pavonana* larvae (0.69 larvae/plant) followed by chlorantraniliprole 18.50% SC @ 0.3 ml/L (0.96 larvae/plant), emamectin benzoate 5% SG @ 0.4 g/L (1.36 larvae/plant) and *Bacillus thuringiensis* subsp. *kurstaki* @ 2 g/L (2.87 larvae/plant). Acetamiprid 20% SP @ 0.2 g/L (3.33 larvae/plant), *Beauveria bassiana* @ 5 g/L (3.38 larvae/plant) and diafenthiuron 50% WP @ 1.2 g/L (3.42 larvae/plant) were statistically at par in effectiveness. The treatments fipronil 5% SC @ 2 ml/L (3.87 larvae/plant) and *Metarhizium anisopliae* @ 5 g/L (4.00 larvae/plant) were statistically on par with each other. After 2nd spray, the treatment cyantraniliprole 10.26% OD @ 1.2 ml/L showed the lowest mean population of 0.47 larvae/plant followed by chlorantraniliprole 18.50% SC @ 0.3 ml/L (0.78 larvae/plant), emamectin benzoate 5% SG @ 0.4 g/L (1.20 larvae/plant), *Bacillus thuringiensis* subsp. *kurstaki* @ 2 g/L (1.69 larvae/plant) and acetamiprid 20% SP @ 0.2 g/L (1.74 larvae/plant) (both on par with each other).The treatments *Beauveria bassiana* @ 5 g/L (2.09 larvae/plant), diafenthiuron 50% WP @ 1.2 g/L (2.20 larvae/plant) and fipronil 5% SC @ 2 ml/L (2.24 larvae/plant) were statistically on par with each other in their efficacy against *C*. *pavonana*. The treatment *Metarhizium anisopliae* @ 5 g/L harbored highest larval population of 2.53 larvae/plant. However, all the treatments were superior to untreated contro l4.38 larvae/plant.The present study is in line with Sambathkumar (2020) who recorded 100 per cent reduction (*in vitro* efficacy study) in *C*. *pavonana* population by spraying chlorantraniliprole 18.5 % SC @ 0.3 ml/L. Similarly, Jemimah *et al*. (2021) also reported that chlorantraniliprole 18.5 % SC @ 0.3 ml/L showed 84.14 per cent reduction in *C*. *pavonana* population on cabbage.

Tobacco caterpillar (*Spodoptera litura*)

After 1st spray, the lowest mean population of *S*. *litura* larvae were recorded in cyantraniliprole 10.26% OD @ 1.2 ml/L (0.62 larvae/plant) followed by chlorantraniliprole 18.50% SC @ 0.3 ml/L (0.98 larvae/

Table 1. Efficacy of different insecticides and biopesticides against major insect pests infesting broccoli during *rabi* 2022-23

Treatments	Dose (g or ml/L)	Mean number of larvae per plant									Mean number of *M. Persicae* per leaf per plant		
		P. xylostella			*C. pavonana*			*S. litura*					
		DBS	1st spray	2nd Spray	DBS	1st spray	2nd spray	DBS	1st spray	2nd spray	DBS	1st spray	2nd spray
Acetamiprid 20% SP	0.2 g	4.00 (1.99)	2.96 (1.72)	2.24 (1.50)	4.80 (2.19)	3.33 (1.82)	1.74 (1.32)	4.27 (2.06)	2.98 (1.71)	2.27 (1.50)	61.53 (7.84)	9.98 (3.15)	6.18 (2.48)
*Bacillus thuringiensis*subsp. *kurstaki*	2 g	4.07 (2.01)	2.40 (1.54)	1.92 (1.38)	5.20 (2.28)	2.87 (1.69)	1.69 (1.30)	4.60 (2.14)	2.64 (1.63)	1.58 (1.25)	59.80 (7.72)	43.29 (6.57)	29.44 (5.42)
Beauveria bassiana	5 g	3.87 (1.96)	2.82 (1.68)	2.02 (1.42)	5.00 (2.23)	3.38 (1.84)	2.09 (1.44)	4.53 (2.12)	2.93 (1.71)	2.11 (1.44)	59.40 (7.70)	49.27 (7.01)	33.44 (5.78)
Cyantraniliprole 10.26% OD	1.2 ml	4.27 (2.06)	0.76 (0.87)	0.51 (0.73)	5.07 (2.25)	0.69 (0.83)	0.47 (0.67)	4.00 (2.00)	0.62 (0.77)	0.58 (0.77)	61.93 (7.86)	13.40 (3.65)	8.47 (2.90)
Chlorantraniliprole 18.50% SC	0.3 ml	4.20 (2.04)	1.11 (1.04)	0.84 (0.91)	4.87 (2.20)	0.96 (0.98)	0.78 (0.89)	3.93 (1.98)	0.98 (0.98)	0.93 (0.96)	63.93 (7.98)	17.42 (4.17)	11.49 (3.38)
Diafenthiuron 50% WP	1.2 g	4.00 (2.00)	2.96 (1.72)	2.40 (1.54)	4.93 (2.22)	3.42 (1.85)	2.20 (1.48)	4.20 (2.04)	3.07 (1.74)	2.40 (1.54)	61.93 (7.86)	21.80 (4.66)	16.89 (4.10)
Emamectin benzoate 5% SG	0.4 g	4.13 (2.03)	1.42 (1.19)	1.24 (1.12)	5.13 (2.26)	1.36 (1.16)	1.20 (1.07)	4.27 (2.06)	1.42 (1.18)	1.31 (1.13)	60.60 (7.77)	43.38 (6.58)	28.17 (5.30)
Fipronil 5% SC	2 ml	4.07 (2.01)	3.40 (1.84)	2.44 (1.55)	5.07 (2.25)	3.87 (1.96)	2.24 (1.49)	4.33 (2.08)	3.27 (1.80)	2.46 (1.56)	60.53 (7.77)	36.67 (6.05)	22.29 (4.72)
Metarhizium anisopliae	5 g	3.80 (1.94)	3.44 (1.85)	2.51 (1.58)	4.93 (2.19)	4.00 (2.00)	2.53 (1.62)	4.40 (2.09)	3.33 (1.83)	2.98 (1.72)	59.67 (7.71)	49.97 (7.06)	33.76 (5.80)
Untreated Control	-	4.33 (2.08)	4.38 (2.09)	4.22 (2.04)	5.20 (2.28)	5.07 (2.25)	4.38 (2.08)	4.60 (2.14)	4.40 (2.09)	3.87 (1.97)	60.87 (7.79)	60.36 (7.75)	46.20 (6.79)
CD at 5%	-	NS	0.110	0.147	NS	0.110	0.124	NS	0.135	0.148	NS	0.394	0.324

DBS- Days before spraying, NS- Non significant, Figures on parentheses are square root transformed values of original data.

plant) and emamectin benzoate 5% SG @ 0.4 g/L (1.42 larvae/plant). The plots treated with *Bacillus thuringiensis* subsp. *kurstaki* @ 2 g/L (2.64 larvae/plant), *Beauveria bassiana* @ 5 g/L (2.93 larvae/plant), acetamiprid 20% SP @ 0.2 g/L (2.98 larvae/plant) and diafenthiuron 50% WP @ 1.2 g/L (3.07 larvae/plant) were statistically on par with each other. Fipronil 5% SC @ 2 ml/L (3.27 larvae/plant) treated plots were statistically equivalent in effectiveness with *Metarhizium anisopliae* @ 5 g/L (3.33 larvae/plant). After 2nd spray, a significantly less number of *S. litura* larvae were recorded incyantraniliprole 10.26% OD @ 1.2 ml/L (0.58 larvae/plant) followed by chlorantraniliprole 18.50% SC @ 0.3 ml/L (0.93 larvae/plant), emamectin benzoate 5% SG @ 0.4 g/L (1.31 larvae/plant) and *Bacillus thuringiensis* subsp. *kurstaki* @ 2 g/L (1.58 larvae/plant) (both on par with each other). The treatments *Beauveria bassiana* @ 5 g/L (2.11 larvae/plant), acetamiprid 20% SP @ 0.2 g/L (2.27 larvae/plant), diafenthiuron 50% WP @ 1.2 g/L (2.40 larvae/plant) and fipronil 5% SC @ 2 ml/L (2.46 larvae/plant) were statistically on par with each other. The treatment *Metarhizium anisopliae* @ 5 g/L (2.98 larvae/plant) harbored highest *S. litura* population. However, all the treatments were significantly superior over untreated control (3.87 larvae/plant).The present study is more or less in accordance with Reddy *et al*. (2017) who reported 63 per cent reduction in *S. litura* population by spraying emamectin benzoate 5% SG @ 0.4 g/L on cabbage. Similarly, Kamde *et al*. (2018) recorded 61.72-75.38 per cent reduction in *S. litura* population on cabbage by spraying cyantraniliprole 10.26% OD @ 1.2 ml/L.

Aphid (*Myzus persciae*)

After 1st spray, the treatment acetamiprid 20% SP @ 0.2 g/L showed maximum efficacy, with lowest *M. Persicae* population (9.98 aphids/leaf/plant) followed by cyantraniliprole 10.26% OD @ 1.2 ml/L (13.40 aphids/leaf/plant), chlorantraniliprole 18.50% SC @ 0.3 ml/L with (17.42 aphids/leaf/plant), diafenthiuron 50% WP @ 1.2 g/L (21.80 aphids/leaf/plant), fipronil 5% SC @ 2 ml/L (36.67 aphids/leaf/plant), *Bacillus thuringiensis* subsp. *kurstaki* @ 2 g/L (43.29 aphids/leaf/plant) and emamectin benzoate 5% SG @ 0.4 g/L (43.38 aphids/leaf/plant) (both on par with each other).The treatments *Beauveria bassiana* @ 5 g/L (49.27 aphids/leaf/plant) and *Metarhizium anisopliae* @ 5 g/L (49.97 aphids/leaf/plant) were statistically equal in efficacy against *M. Persicae* population. The plots treated with acetamiprid 20% SP @ 0.2 g/L showed the lowest mean population (6.18 aphids/leaf/plant) after 2nd spray followed by cyantraniliprole 10.26% OD @ 1.2 ml/L (8.47 aphids/leaf/plant), chlorantraniliprole 18.50% SC @ 0.3 ml/L with (11.49 aphids/leaf/plant), diafenthiuron 50% WP @ 1.2 g/L (16.89 aphids/leaf/plant), fipronil 5% SC @ 2 ml/L (22.29 aphids/leaf/plant), emamectin benzoate 5% SG @ 0.4 g/L (28.17 aphids/leaf/plant) and *Bacillus thuringiensis* subsp. *kurstaki* @ 2 g/L (29.44 aphids/leaf/plant) (both on par with each other). *Beauveria bassiana* @ 5 g/L (33.44 aphids/leaf/plant) and *Metarhizium anisopliae* @ 5 g/L (46.20 aphids/leaf/plant) were statistically at par in effectiveness. All the treatments selected for efficacy study were significantly effective over untreated control (46.20 aphids/leaf/plant).Srivastava *et al*. (2016) reported acetamiprid 20% SP @ 150 g/ha caused 83.05 per cent reduction in aphid population on cabbage. Bhede *et al*. (2018) revealed that cyantraniliprole 10.26% OD @ 600 ml/ha caused 96.27 per cent reduction in aphid population on cauliflower. The present results are in line with the above researchers.

Based on the findings, it can be concluded that cyantraniliprole 10.26% OD @ 1.2 ml/L and chlorantraniliprole 18.50% SC @ 0.3 ml/L can be used for effective management of insect pests in broccoli ecosystem.

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