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# Efficacy of novel meta-diamide molecule on yellow stem borer on rice and its impact on natural enemies in TBP command area of Karnataka State

**Kirankumar R, Sujay Hurali, Vijayachandra Reddy S, Basavanjali, Hareesh Shiralli and Honnayya**

**Abstract**
**Aim:** To evaluate the Efficacy of novel meta-diamide molecule, broflanilide 30% SC against yellow stem borer on rice and its impact on natural enemies in TBP command area.
**Study Design:** Randomized Block Design (RBD), having 7 treatments which were replicated thrice in a net experimental area of 5 m x 5 m each. Nursery of rice variety BPT-5204 transplanted after 25 days of sowing at 20 cm x 10 cm hill spacing. All the agronomic practices were followed during crop growth period.
**Place and Duration of Study:** The present experiment was conducted in *Kharif* 2018 and 2019 at Agriculture Research Station, Gangavathi, Karnataka, India.
**Methodology:** The experiment was conducted using Randomized Block Design (RBD), in the experimental farm of Agricultural research station, Gangavathi, Koppal.
**Results:** Due to an increase in environmental awareness, resurgence problems and health hazards, it is necessary to identify the effective as well as economical and ecofriendly chemical insecticides while rice plant compensates low percentage of dead hearts, but 1-3% loss of yield is expected for every percent of white ear head. Further, in case of Yellow stem borer results reveals that, significant control was found in case of control of white ear head with maximum reduction over control observed in treatment broflanilide 30% SC@ 25.20 g.a.i./ha (87.94% ROC), followed by broflanilide 30% SC @ 19.20 g.a.i/ha which recorded 84.59 per cent ROC.
**Conclusion:** The pooled data on the efficacy of different treatment schedules of broflanilide 30% SC against major insect pest of Rice *i.e.* stem borer. All the treated plots provided significant reduction of pest infestation along with significant yield increase but the best protection and less impact on natural enemies was obtained from the plots treated with broflanilide 30% SC @ 25.2 g.a.i./ha and broflanilide 30% SC @ 19.5 g.a.i/ha followed by broflanilide 30% SC @ 13.2 g.a.i./ha. All the treatments were on par with each other and significantly superior over the other comparative treatments and untreated control regarding pest control.

**Keywords:** Broflanilide, efficacy, natural enemies and stem borer

## Introduction
Rice (*Oryza sativa* L.) is one of the world's most important crops, providing a staple food for nearly half of the global population (Heinrichs *et al*., 2017) [3]. Almost 90% of rice is grown and consumed in Asia. It is used as a food for more than two billion people in developing countries of Asia (Khush and Brar, 2002) [5]. Rice is grown in area about 12.38 lakh hectare, Production of 38.18 lakh tonns and productivity of 3084 kg/ha in Karnataka during 2020-21 (Annon, 2020) [1]. To meet the feeding demand of increasing population, it is imperative to increase the production per unit of land and water. The productivity of rice is limited by many biotic and abiotic factors. Field incidence of insect pests is highly dependent on crop stage and prevailing abiotic as well as biotic factors that affect their multiplication and growth. Pests of rice have been grouped in various categories based on their nature of damage like sucking pests which include brown plant hopper *(Nilaparvata lugens* Stal.), white backed plant hopper (*Sogatella furcifera* Horvath), green leaf hopper (*Nephotettix nigropictus* Stal.) and gundhi bug (*Leptocorisa varicornis* Thunb.); the defoliator insects like grasshopper, army worm, leaf folder, case worm, two horned caterpillar and rice hispa *etc.* In India, *Scirpophaga incertulas* have assumed to be number one pest status and attacks the rice crop at all growth stages (Pasulu *et al*., 2002) [9]. Globally YSB alone causes yield loss of 10 Million tones and 50 per cent of the insecticides are used for their management in the rice field (Huesing, 2004) [4].

Rice production is linearly correlated with insecticide use in rice. Use of insecticides has positive impact on rice production (Misra and Parida, 2004) [6]. Due to an increase in environmental awareness, resurgence problems and health hazards, it is necessary to identify the effective as well as economical and ecofriendly chemical insecticides while rice plant compensates low percentage of dead hearts, but 1-3% loss of yield is expected for every percent of white ear head (Pathak *et al*., 1971) [10]. Under such circumstance use of novel insecticides having specificity towards target insects is the need for justification of chemical control as the first line of defense. Currently, the green chemistry molecules tested for the control of lepidopteran insect pests include broflanilide is a meta-diamide [3-benzamido-N-(4-(perfluoropropan-2-yl) phenyl) benzamide] (Nakao and Banba, 2016) [7]. It has been reported that broflanilide is metabolized to desmethyl-broflanilide and that it acts as a non-competitive resistant-to-dieldrin (RDL) γ-aminobutyric acid (GABA) receptor antagonist (Nakao *et al*., 2013) [8].

To combat these pests although IPM practices have been developed, but the farmers usually opted for insecticides as their first preference. Keeping these facts in view the present investigation broflanilide 30% SC as newer and safe chemistry molecule was proposed against rice yellow stem borer.

## Materials and Methods

The experiment was conducted in the experimental farm of Agricultural research station, Gangavathi, Koppal, during *Kharif* 2018 and *Kharif* 2019 in Randomized Block Design (RBD), having 7 treatments which were replicated thrice in a net experimental area of 5 m x 5 m each. Nursery of rice variety BPT- 5204 transplanted after 25 days of sowing at 20 cm x 10 cm hill spacing. All the agronomic practices were followed during crop growth period. The treatments were.

| Tr. No | Treatments | *G.A.I.*/ha |
|---|---|---|
| $T_1$ | Broflanilide 30% SC | 13.2 |
| $T_2$ | Broflanilide 30% SC | 19.2 |
| $T_3$ | Broflanilide 30% SC | 25.2 |
| $T_4$ | Chlorpyriphos 20% EC | 250 |
| $T_5$ | Cartap hydrochloride 75% SG | 375 |
| $T_6$ | Chlorantriniliprole 0.4% GR | 40 |
| $T_7$ | Untreated Control | --- |

The application of treatments started at the initiation of pest incidence and was repeated after 14 days. The incidence of stem borer was recorded in terms of dead hearts at 3, 5, 7, 10 days after each spray and also in terms of white ear heads at 10 days after the last spray and at harvest time. The yield per plot was recorded at harvest. Natural enemies population *viz*., mired bug and spider was recorded before application and 10 days after each spray. The data were analyzed statistically by using Randomized block design (RBD), coefficient of variance, critical difference and standard error were calculated and after that data were subjected to transformation like chi-square and angular transformation. The percent dead heart and white ear head calculated by using the following formula.

$$Percent\ dead\ heart = \frac{\text{Number of dead heart per hill}}{\text{Total no.of (healthy + damaged)tillers per hill}} \times 100$$

$$\%\ White\ ear\ head = \frac{\text{Number of white ear per hill}}{\text{Total no.of paniclre bearing tillers per hill}} \times 100$$

## Result and discussion

The experiment on "Efficacy of novel meta-diamide molecule, broflanilide 30% SC against yellow stem borer on rice and its impact on natural enemies in TBP command area" was conducted during *Kharif* 2018 and *Kharif* 2019. The data of the both the season was pooled, result and discussion was as follows.

### Yellow stem borer

Application of the insecticides were done when the dead heart symptoms started appearing, it was notieced that stem borer population in the experimental plot and when we recorded that the dead heart it was varied from 4.72 to 7.06 per cent. Further observations were recorded at 3rd, 5th, 7th and 10th days after 1st application insecticides, there was a reduction in the dead heart was found in all the treatment but minimum dead heart (1.50%) was observed in the plot treated with new green insecticide, broflanilide 30% SC @ 25.2 *G.A.I.*/ha compared to 12.38 per cent in untreated check at 10 days after the first application, this was followed by broflanilide 30% SC @ 19.2 *G.A.I.*/ha which recorded 1.85 percent dead heart and maximum reduction over control observed in treatment broflanilide 30% SC@ 25.20 *G.A.I./ha* (89.01% ROC), followed by broflanilide 30% SC @ 19.20 g.a.i/ha which recorded 87.15 per cent ROC. Among the chemical treatments least damage was noticed in the plot treated with Chlorantriniliprole 0.4% GR which have recorded 2.96 per cent dead heart per hill (Table 1).

Similar trend was noticed at 3, 5, 7 and 10 days after second application also. broflanilide 30% SC @ 25.2 and 19.2 *G.A.I.*/ha were found to be effective and superior treatments in reducing per cent dead heart at 10 days after second application. The higher and middle dosage (25.2 and 19.2 *G.A.I.*/ha) of broflanilide 30% SC recorded maximum per cent reduction over control (89.53% and 87.81% ROC) and followed by broflanilide 30% SC 13.2 @ *G.A.I.*/ha (79.02% ROC). Whereas, least per cent reduction over control was observed in car tap hydrochloride 0.4GR @ 40 *G.A.I.*/ha (Table 1 & 2).

The data on per cent white ear heads due to stem borer attack was recorded at pre harvesting stage. Higher dose (25.2 *G.A.I.*/ha) of by broflanilide 30% SC recorded lowest per cent white ear heads of 1.61 per cent white ear head followed by broflanilide 3% SC@ 19.5*g.a.i.*/ha which recorded 2.07 per cent of white ear head and this was followed by third lower dose broflanilide 30% SC @ 13.2 *G.A.I.*/ha (2.82% white ear head), untreated plot noticed highest white ear head (13.46% white ear head). When we carried out the reduction over control with respect to white ear head, maximum reduction over control observed in treatment broflanilide 30% SC@ 25.20 *G.A.I./ha* (87.94% ROC), followed by broflanilide 30% SC @ 19.20 g.a.i/ha which recorded 84.59 per cent ROC (Table 2).

### Natural enemy population

The predators like spiders and mired bugs were observed in

paddy ecosystem during cropping season. One day before spray spider and mired bug population were found non-significant in all treatments it indicates that predator population was uniformly distributed in all the treatments. Pooled data of 2018-2019 confirms that application of novel meta-diamide molecule, broflanilide 30% SC has less impact on natural enemy population (Table 3).

**Grain yield**

The data on the grain yield presented in the Table 3 indicate that, all the insecticidal treatments recorded the higher grain yield compared to the untreated control. However maximum yield was recorded in the treatment broflanilide 30% SC @25.2 g.a.i/ha followed by its next lower dose 19.2 and 13.2 g.a.i/ha (76.05, 73.89 and 70.28 q/ha respectively) which were followed by Chlorantriniliprole 0.4%GR @ 40 recorded grain yield @ 66.43 q/ha, car tap hydrochloride 75% SG @ 375 g.a.i/ha recorded yield 65.43 q/ha and Chlorpyriphos 20% EC @ 250 ml/ha recorded yield 61.40 q/ha whereas significantly lowest yield was recorded by untreated control @ 52.71 q/ha, respectively.

The present findings were in accordance with Tang *et al*., 2021 reported that broflanilide should be an important new tool for the effective control of dioxide- and avermectin-resistant H Armigera and S Exigua. Similarly, rachappa *et al*., 2020 [11] shown that new green insecticide molecule, broflanilide 30% SC at both the dosage @18.6 and @12.6 *G.A.I.*/ha were highly effective in controlling pigeon pea pod borers by registering lowest mean larval numbers of *Helicoverpa armigera* and *Maruca vitrata* and had no effect on the numbers of predatory such as spiders and coccinellids. And also, Abro *et al*., 2013 [2] indicated that application of insecticides significantly reduced the infestation of rice stem borer in rice crop compared with control treatment and significantly increased the filling of rice grain and yield of rice crop. On the basis of reduction in YSB infestation, increase in grain yield, and compatibility with natural enemies, Chlorantriniliprole 0.4% G was proved to be the best of all the insecticides for YSB management system (Rahaman and Stout, 2019) [12].

**Economics**

The data on Cost Benefit ratio of Broflanilide 30% is presented in the Table 4 indicate that, among all treatments, treatment (T3) recorded the higher Cost Benefit ratio (1:2.30) compared to other treatments and untreated control. However maximum yield was recorded in the treatment T3 broflanilide 30% SC. Based on the findings, it can be concluded that, the novel meta-diamide insecticide *i.e.* broflanilide 30% SC @ 19.2-25.2 *gram active ingredient per* ha found over all superior in reducing the plant damage especially dead heart and controls pod health especially white ear and obtaining the higher grain yield in the study area.

**Table 1:** Effect of Broflanilide 30% against yellow stem borer on paddy (Pooled)

| Tr. No | Treatments | *G.A.I.*/ha | 1st application | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | % Dead heart | | | | | % ROC |
| | | | PTC | 3 DAA | 5DAA | 7 DAA | 10 DAA | |
| $T_1$ | Broflanilide 30% SC | 13.2 | 5.88 (14.19) | 3.84 (11.44) | 3.81 (11.39) | 3.31 (10.58) | 2.79 (9.73) | 78.32 |
| $T_2$ | Broflanilide 30% SC | 19.2 | 5.74 (14.02) | 4.17 (11.85) | 3.22 (10.47) | 3.21 (10.52) | 1.85 (7.91) | 87.15 |
| $T_3$ | Broflanilide 30% SC | 25.2 | 4.72 (13.21) | 4.47 (13.04) | 2.98 10.07) | 2.87 (9.94) | 1.50 (7.08) | 89.01 |
| $T_4$ | Chlorpyriphos 20% EC | 250 | 7.06 (15.14) | 5.26 (13.56) | 5.16 (13.27) | 4.88 (12.89) | 3.72 (11.25) | 60.59 |
| $T_5$ | Cartap hydrochloride 75% SG | 375 | 6.97 (14.68) | 4.88 (12.92) | 4.74 (12.71) | 4.41 (12.89) | 3.43 (10.79) | 72.55 |
| $T_6$ | Chlorantriniliprole 0.4% GR | 40 | 5.06 (13.15) | 5.20 (13.34) | 4.52 (12.38) | 3.43 (10.79) | 2.96 (10.03) | 73.32 |
| $T_7$ | Untreated Control | --- | 5.09 (13.19) | 7.23 (15.28) | 9.64 (17.81) | 10.70 (19.32) | 12.38 (20.67) | |
| SEm+ | | | 0.38 | 0.04 | 0.49 | 0.79 | 0.81 | |
| CD at 5% | | | NS | 0.12 | 0.16 | 2.43 | 2.50 | |
| CV | | | 2.10 | 1.77 | 6.74 | 7.64 | 5.93 | |

NS = Non-significant; Values are mean of three replications; PTC = Pretreatment count; DAA = Day after application; Figures in the parenthesis are arc sign transferred value, ROC-Reduction over Control

**Table 2:** Effect of Broflanilide 30%SC against yellow stem borer on paddy and the grain yield (Pooled)

| Tr. No | Treatments | *G.A.I.*/ha | 2nd application | | | | | | % White ears | % ROC | Yield q/ha |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | % Dead heart | | | | | % ROC | | | |
| | | | PTC | 3 DAA | 5DAA | 7 DAA | 10 DAA | | | | |
| $T_1$ | Broflanilide 30% SC | 13.2 | 4.73 (12.32) | 4.29 (11.76) | 3.15 (10.17) | 2.58 (9.24) | 2.44 (8.97) | 80.42 | 2.82 (9.65) | 79.02 | 70.28 |
| $T_2$ | Broflanilide 30% SC | 19.2 | 4.77 (12.38) | 3.63 (10.57) | 2.52 (8.98) | 1.64 (7.34) | 1.52 (7.07) | 87.81 | 2.07 (8.25) | 84.59 | 73.89 |
| $T_3$ | Broflanilide 30% SC | 25.2 | 4.75 (12.38) | 2.95 (9.56) | 2.04 (8.12) | 1.37 (6.72) | 1.31 (6.55) | 89.53 | 1.61 (7.27) | 87.94 | 76.05 |
| $T_4$ | Chlorpyriphos 20% EC | 250 | 5.04 (12.80) | 5.02 (12.82) | 4.43 (12.06) | 3.50 (10.78) | 3.39 (10.60) | 72.80 | 4.36 (11.95) | 67.98 | 61.40 |
| $T_5$ | Cartap hydrochloride 75% SG | 375 | 5.19 (13.01) | 4.98 (12.73) | 3.97 (11.46) | 3.28 (10.42) | 3.26 (10.40) | 73.81 | 3.55 (10.86) | 73.62 | 65.43 |
| $T_6$ | Chlorantriniliprole 0.4% GR | 40 | 4.70 | 4.25 | 3.13 | 2.79 | 2.70 | 78.34 | 3.47 | 74.07 | 66.43 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (12.28) | (11.73) | (10.16) | (9.61) | (9.46) | | (10.67) | | |
| $T_7$ | Untreated Control | --- | 9.60 (17.84) | 9.90 (18.22) | 10.60 (18.94) | 11.28 (19.59) | 12.47 (20.67) | - | 13.46 (21.50) | - | 52.71 |
| SEm± | | | 0.08 | 0.06 | 0.07 | 0.07 | 0.06 | | 0.30 | | 0.91 |
| CD at 5% | | | 0.15 | 0.04 | 0.08 | 0.08 | 0.09 | | 0.78 | | 0.98 |
| CV | | | 1.50 | 1.15 | 1.66 | 2.05 | 1.87 | | 0.90 | | 1.44 |

NS = Non-significant, Values are mean of three replications, PTC = Pretreatment count, DAA = Day after application, Figures in the parenthesis are arc sign transferred value, ROC-Reduction over Control

**Table 3:** Effect of Broflanilide 30% SC against natural enemies and grain yield in rice ecosystem (Pooled)

| Tr. No | Treatments | *G.A.I.*/ha | Mean mired bug population/hill | | | Mean spider population/hill | | |
|---|---|---|---|---|---|---|---|---|
| | | | PTC | 10 DAA (1st application) | 10 DAA (2nd application | PTC | 10 DAA (1st application) | 10 DAA (2nd application |
| $T_1$ | Broflanilide 30% SC | 13.2 | 3.74 (6.18) | 5.51 (2.55) | 7.42 (2.89) | 3.06 (5.42) | 4.97 (2.44) | 5.77 (2.59) |
| $T_2$ | Broflanilide 30% SC) | 19.2 | 4.09 (6.49) | 5.35 (2.51) | 7.83 (2.96) | 3.02 (1.98) | 4.45 (2.33) | 5.55 (2.54) |
| $T_3$ | Broflanilide 30% SC | 25.2 | 4.08 (6.30) | 5.47 (2.54) | 7.32 (2.87) | 3.03 (5.24) | 4.29 (2.28) | 5.30 (2.51) |
| $T_4$ | Chlorpyriphos 20% EC | 250 | 3.22 (5.03) | 5.16 (2.47) | 6.83 (2.77) | 2.89 (5.09) | 3.85 (2.21) | 5.63 (2.57) |
| $T_5$ | Cartap hydrochloride 75% SG | 375 | 3.39 (5.07) | 5.02 (2.45) | 7.63 (2.90) | 2.81 (4.94) | 4.33 (2.30) | 5.25 (2.50) |
| $T_6$ | Chlorantriniliprole 0.4%GR | 40 | 3.34 (4.73) | 4.82 (2.41) | 7.02 (2.81) | 3.75 (5.84) | 4.08 (2.25) | 5.18 (2.48) |
| $T_7$ | Untreated Control | --- | 3.88 (6.21) | 5.47 (2.54) | 7.55 (2.88) | 3.28 (5.83) | 4.59 (2.36) | 5.93 (2.63) |
| | SEm± | | 0.20 | 0.10 | 0.15 | 0.22 | 0.10 | 0.13 |
| | CD at 5% | | 0.58 | 0.31 | 0.45 | 0.66 | 0.29 | 0.41 |

NS = Non-significant; Values are mean of three replications; PTC = Pretreatment count; DAA = Day after application; Figures in parentheses are $\sqrt{X+0.5}$ transformed value

**Table 4:** Cost-Benefit Ratio of Broflanilide 30% SC -Pooled

| Tr. No | Treatments | Dose (*G.A.I.*/ha) | Agronomic Cost | Cost of inputs (Cost of insecticide/ha + Cost of labour for application /ha) | Yield (q/ha) | Average total Cost (Rs/q) | Average gross returns (Rs/q) | Net returns (Rs) | Cost -Benefit Ratio |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | Broflanilide 30% SC | 13.2 | 59591 | 1650 | 70.28 | 61241 | 133532 | 72291 | 1:2.18 |
| $T_2$ | Broflanilide 30% SC | 19.2 | 59591 | 2400 | 73.89 | 61991 | 140391 | 78400 | 1:2.26 |
| $T_3$ | Broflanilide 30% SC | 25.2 | 59591 | 3150 | 76.05 | 62741 | 144495 | 81754 | 1:2.30 |
| $T_4$ | Chlorpyriphos 20% EC | 250 | 59591 | 2000 | 61.40 | 61591 | 116660 | 55069 | 1:1.89 |
| $T_5$ | Cartap hydrochloride 75% SG | 375 | 59591 | 1450 | 65.43 | 61041 | 124317 | 63276 | 1:2.04 |
| $T_6$ | Chlorantriniliprole 0.4% GR | 40 | 59591 | 2000 | 66.43 | 61591 | 126217 | 64626 | 1:2.05 |
| $T_7$ | Untreated Control | --- | 59591 | - | 46.71 | 59591 | 88749 | 29158 | 1:1.49 |

**Market rates:** Cost of the chemical: Broflanilide 30% SC - Rs. 960/25 g, Chlorpyriphos 20% EC - Rs. 800/lit, Cartap hydrochloride 75% SG - Rs. 1160/kg, Chlorantriniliprole 0.4% GR - Rs. 800 / 4kg, Labour cost: Rs. 300/person, selling price of the produce (paddy): Rs. 1,900/q

## Conclusion

Based on the evaluations it can be concluded that, the novel meta-diamide insecticide *i.e.* broflanilide 30%SC @ 19.2 – 25.2 g.a.i/ha found over all superior in reducing the dead heart and white ear and obtaining the higher grain yield followed by car tap hydrochloride 75% SG @ 375 g.a.i/ha, Chlorantriniliprole 0.4% GR @ 40 g.a.i/ha and Chlorpyriphos 20% EC @ 250 ml/*ha*. There was no adverse effect on the natural enemies *viz*., mired bugs and spiders by the novel meta-diamide molecule.

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## Authors' Contributions

'Kirankumar R and Sujay Hurali' designed the study and wrote the protocol conducted the experiment. 'Vijayachandra Reddy S, Basavanjali, Hareesh Shiralli and Honnayya' prepared for the first draft of the manuscript and made statistical analysis, managed the literature searches of the study. We all authors read and approved the final manuscript".

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