



Infestation Suppression under Evaluation of Ecofriendly Insecticides against Major Insect Pests of Rice in Eastern Uttar Pradesh Conditions

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The present study was undertaken to analysis the suppression of infestation over check plot under evaluation of ecofriendly insecticides against major insect pests of rice in eastern Uttar Pradesh conditions for the two consecutive years (2014 and 2015) at farmer field of district Deoria under the supervision of Department of Entomology, B.R.D.P.G. College, Deoria, Uttar Pradesh, India. There were 10 treatments (09 insecticides + 01 check) evaluated under randomized block design (RBD) by transplanting method of rice cultivation on localized popular rice cultivar Samba Mahsuri (BPT-5204). The insecticide treatments comprise 9 insecticides (CartapHcl, 50 SP, Indoxacarb 14.5 SC, Imidacloprid 17.8 SL, Chlorpyrifos 20 EC, Thiamethoxam 25 WG, Chlorantraniliprole 18.5 SC, Azadirachtin (Neem Oil) 0.03 EC, *Bacillus thuringiensis kurstaki* (Btk) 3.5 WP, and combination of Neem Oil 0.03 EC + Btk 3.5 WP). This evaluation was observed most effective ecofriendly insecticides concerned to lowest infestation, highest suppression of infestation over check plot, and

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highest yield. The inferences of suppression over check plot and yield of rice crop were based on non-significant ecofriendly insecticides for lowest infestation. There were 2 insecticides (CartapHcl and Imidacloprid) inference non-significant for highest suppression of infestation over check. There were 3 insecticides (CartapHcl, Imidacloprid, and Neem Oil + Btk) inference non-significant for lowest infestation and highest yield respectively. The mean ranking and inference of suppression over check were similar to inference of non-significant ecofriendly insecticides for lowest infestation as, Imidacloprid, CartapHcl, and Neem Oil + Btk respectively.

Keywords: Infestation suppression; ecofriendly insecticides; major insect pests of rice; Eastern Uttar Pradesh; India.

1. INTRODUCTION

Rice (*Oryza sativa* Linn.) is one of the most staple foods of the world as well as India [1-5]. The rice production provides livelihood and food security to the about half of the world population and more than half of the India population. It is mostly produced and consumed in Asian countries. The rice fragrance makes meal delicious to the entire world [6-8]. India shares, 22.46 % (109.7 mt) of the world rice production (488.31 mt) and occupies second position after China, 28.18% (137.64 mt) [6-8]. The Uttar Pradesh state shares, 12.53 % (13.75 mt) of the national rice production of India occupies second position followed by West Bengal state (17%) and first position in rice production area [6-8]. Being occupying first position in rice crop area, the Uttar Pradesh state is not standing on highest rice production in India. The major concern of this lower production of rice is non-modern approach of production and crop stress. The insect pests are major biotic stresses of rice. The rice crop losses caused by insect pests have been sharing about 60 to 95 % over the world and about 21 to 51% in the India respectively [1-5]. There are about 800 insect pest species infesting rice crop over the world. Being the most favorable environment congenial for rice production and proliferation for insect pests, there are about 250 insect pest species infesting rice crop in India. Among 20 major insect pests of rice of major economic significance, there have been recognized 12 of national significance and 08 of regional significance respectively. The infestation of rice insect pests effects every growth stage and plant parts of rice [1,4,5].

Insect pest management is the continuous process varied among complex ecosystem of nature. The regular efforts are necessary to develop effective strategy for insect pest management with particular agroecosystem under changing climatic conditions [1,4,5]. Being practicing modern approaches of rice production

in India, most of the farmers are applying rice insect pest management practices as finishing approach of insect pests without considering the significant role of bioagents in suppression of insect pests infestations [4,5]. Being the most effective role of pesticides in the pest management, chemical insecticides are continuously applying pesticides for insect pest management in rice crop production [4,5]. The augmentation of crop production needs pesticides as essential inputs has been universally considered. The insecticides application always be perceived last resort for insect pest management [4,5]. The scientific community have been continuously evaluating the efficacy for various insecticides including conventional and novel chemical insecticides and biorational insecticides for ecofriendly pest management. The evaluation of efficacy of novel chemical and biorational insecticides have been reported scanty for ecofriendly pest management under eastern Uttar Pradesh conditions. Therefore, the present research work was conducted the evaluation of efficacy of novel chemical and biorational insecticides for effective ecofriendly pest management based on market availability and scientific community thrust under eastern Uttar Pradesh conditions.

Chakraborty [9] and Chakraborty and Deb [10] both have been studied that, the infestations of yellow stemborer (*Scirpophaga incertulus* Walker) and common rice leaf folder (*Cnaphalocrocis medinalis* Guenee) were lowered by Imidacloprid. Kulagod et al. [11] have been found that, the infestations of yellow stemborer (*Scirpophaga incertulus* Walker) and common rice leaf folder (*Cnaphalocrocis medinalis* Guenee) were lowered by biorationals as Azadirachtin and *Bacillus thuringiensis*, Berliner (Bt) formulations. Rath et al. [12] have been observed that, the infestations of yellow stemborer (*Scirpophaga incertulus* Walker) and rice earheadbug (*Leptocorisa acuta* Thunberg) were recorded lowest in Imidacloprid and highest

grain yield was recorded in Thiamethoxam treated plots. Sarao et al. [13] and Tigga et al. [14] have been studied that, the infestation of yellow stem borer (*Scirpophaga incertulus* Walker) and rice earhead bug (*Leptocorisca acuta* Thunberg) were lowered by Imidacloprid.

2. MATERIALS AND METHODS

The present study was undertaken to analysis the suppression of infestation over check plot under evaluation of ecofriendly insecticides against major insect pests of rice in eastern Uttar Pradesh conditions for the two consecutive years (2014 and 2015) at farmer field of district Deoria under the supervision of Department of Entomology, B.R.D.P.G. College, Deoria, Uttar Pradesh, India. There were 10 treatments (09 insecticides + 01 check) evaluated under randomized block design (RBD) by transplanting method of rice cultivation on localized popular rice cultivar 'Samba Mahsuri (BPT-5204)'. The insecticide treatments comprise 9 insecticides (Cartap Hydrochloride (CartapHCl), 50 SP, Indoxacarb 14.5 SC, Imidacloprid 17.8 SL, Chlorpyrifos 20 EC, Thiamethoxam 25 WG, Chlorantraniliprole 18.5 SC, Azadirachtin (Neem Oil) 0.03 EC, *Bacillus thuringiensis kurstaki* (Btk) 3.5 WP, and combination of Neem Oil 0.03 EC + Btk 3.5 WP). This confined spot of study, represents the conducive environment for survival and proliferation of insect pests in rice ecosystem under eastern Uttar Pradesh conditions. The Spray formulations selected as recommended for low land rice ecosystems to avoid leaching and toxicity to beneficial soil inhabitants of granular formulations despite effectivity. Application of insecticides spraying were taken for two times at 30 days and 45 days after transplanting (30 DAT and 45 DAT). Samples were taken 03 times at 03, 07 and 14 days after spraying per spray of insecticides and single sample before first spray of insecticides respectively. The duration of rice crops started from pre week of August to mid-week of November for about 110 days. There were 5 samples collected per plot at the size of 20 m². Each plot was selected 5 spots (4 in the corner and one in the center) at 01 hill/spot to observe infestation, and also at each plot, 05 net sweeps were made randomly at every 05 steps to observe abundance of insect pest species. The spraying of insecticides was made by manually operated knapsack sprayer with hollow cone nozzle @ 500 l/ha spray volume. The timing of sampling was 9.30 A.M. to 12.30 P.M. and timing of spraying was 2.30 P.M. to 4.30 P.M.

respectively. Each observation was recorded % infestation of major insect pests and yield of rice crop to evaluate efficacy of treated ecofriendly insecticides. This observation was analyzed the suppression of infestation over check plot of major insect pests of rice during evaluation most effective ecofriendly insecticides concerned to lowest infestation and highest yield respectively.

Surveillance was conducted as per methodology of agroecosystem analysis (AESAs) (Pontius et al. [15]) modified as accessibility. Taxonomic identification was verified with texts of reference, i.e., Dale [16], Barrion and Litsinger [17], Pathak and Khan [1], David and Ananthakrishnan [18]; Rice knowledge management portal (RKMP); and Subject experts respectively. The statistical inferences were verified with texts of reference, i.e., Dhamu & Ramamoorthy [19], and Rangaswamy [20]. The formula of suppression of infestation over check was adopted as follows,

1. Suppression of infestation over check (%) =

(% of Infestation in treated plot over the check plot - 100)

2. % of Infestation in treated plot over the check plot =

$$\frac{\text{Infestation of insect pest in treated plot} \times 100}{\text{Infestation of insect pest in check plot}}$$

3. RESULTS AND DISCUSSION

The suppression of infestation over check plot was observed under evaluation of efficacy of some novel ecofriendly insecticides on infestation of major insect pests of rice for the two consecutive years 2014 and 2015 respectively. The infestations of major insect pests of rice were observed for most serious insect pests, which were 1.Yellow stem borer (*Scirpophaga incertulus* Walker), 2.Common rice leaf folder (*Cnaphalocrosis medinalis* Guenee), 3.Brown planthopper (*Nilaparvata lugens* Stal), 4.Rice hispa (*Dicladispa armigera* Oliver), and 5.Rice earhead bug (*Leptocorisca acuta* Thunberg). Of the total observed evaluation of ecofriendly insecticides on infestation of major insect pests of rice for pooled of both the years 2014 and 2015 were inference non-significant for highest suppression over check (SPOC) as, 3 insecticides (CartapHCl, Imidacloprid, and Neem Oil + Btk) for Yellow stem borer (*Scirpophaga incertulus* Walker), Common rice

leafhopper (*Cnaphalocrosis medinalis* Guenee), and Brown planthopper (*Nilaparvata lugens* Stal); 1 insecticide (Imidacloprid) for Rice hispa (*Diuraphis armigera* Oliver); and 2 insecticides (Imidacloprid and Chlorpyrifos) for Rice earheadbug (*Leptocorisa acuta* Thunberg) respectively (Table 1 and Fig. 1).

Of the total observed evaluation of ecofriendly insecticides against major insect pests of rice under suppression over check (SPOC) for pooled of both the years 2014 and 2015, there were 3 insecticides (CartapHcl, Imidacloprid, and Neem Oil + Btk) inference non-significant for highest suppression over check (SPOC) under first application (30 DAT) and second application (45 DAT), based on evaluation of non-significant ecofriendly insecticides for lowest infestation as, CartapHcl, Imidacloprid, and Neem Oil + Btk respectively. The mean of evaluation under suppression over check was observed as, 2 insecticides (CartapHcl and Imidacloprid) inference non-significant for highest suppression over check under mean of first application and second application, based on mean evaluation of non-significant ecofriendly insecticides for lowest infestation as, CartapHcl, Imidacloprid, and Neem Oil + Btk respectively. Of the total observed infestation of major insect pests of rice for pooled of both the years 2014 and 2015, there were 3 insecticides (CartapHcl, Imidacloprid, and Neem Oil + Btk) inference non-significant for lowest infestation under first application (30 DAT); and 4 insecticides (CartapHcl, Imidacloprid, Chlorantraniliprole, and Neem Oil + Btk) inference non-significant for lowest infestation under second application (45 DAT) respectively. The mean of evaluation was observed as, 3 insecticides (CartapHcl, Imidacloprid, and Neem Oil + Btk) inference non-significant for lowest infestation under mean of major insect pests of rice and mean of first application and second application; and along with 3 insecticides (CartapHcl, Imidacloprid, and Neem Oil + Btk) were also inference non-significant for highest yield respectively. Of the most effective ecofriendly insecticides observed on infestation of major insect pests of rice for pooled of both the years 2014 and 2015, there were 2 insecticides (CartapHcl and Imidacloprid) inference non-significant for highest suppression over check (SPOC); 3 insecticides (CartapHcl, Imidacloprid, and Neem Oil + Btk) inference non-significant for lowest infestation; and 3 insecticides (CartapHcl, Imidacloprid, and Neem Oil + Btk) inference non-significant for highest

yield for mean of major insect pests of rice respectively (Table 2 and Fig. 2).

The ranking of evaluation of ecofriendly insecticides under suppression over check (SPOC) against major insect pests of rice was observed as, Imidacloprid > CartapHcl > Neem Oil + Btk > Chlorantraniliprole > Indoxacarb > Chlorpyrifos > Thiamethoxam > Neem Oil > Btk for highest suppression over check; Imidacloprid > CartapHcl > Neem Oil + Btk > Chlorantraniliprole > Indoxacarb > Chlorpyrifos > Thiamethoxam > Neem Oil > Btk for lowest infestation of insect pests; CartapHcl > Imidacloprid > Neem Oil + Btk > Chlorantraniliprole > Indoxacarb > Chlorpyrifos > Neem Oil > Thiamethoxam > Btk for highest yield; and Imidacloprid > CartapHcl > Neem Oil + Btk > Chlorantraniliprole > Indoxacarb > Chlorpyrifos > Thiamethoxam > Neem Oil > Btk for mean of lowest infestation, highest suppression over check, and highest yield respectively (Table 3). Similar findings were reported by Chakraborty [9], Chakraborty and Deb [10], Kulagod et al. [11], CRRI [21], Rath et al. [12], Sarao et al. [13] and Tigga et al. [14].

Present research work was adopted the non-significant lowest infestation for observation of highest suppression of infestation over check plot as scale to confined efficacy of insecticides as ecofriendly. There were 3 insecticides (CartapHcl, Imidacloprid, and Neem Oil + Btk) inference non-significant for lowest infestation and highest yield respectively. Though, CartapHcl was being most effective insecticides for major insect pests of rice among 3 insecticides (CartapHcl, > Imidacloprid > Neem Oil + Btk) as inference non-significantly for highest yield, but this observation was changed in highest suppression of infestation over check plot most effectively as, Imidacloprid > CartapHcl > Neem Oil + Btk respectively. Though, all these 3 insecticides were being most effective ecofriendly insecticides as, Imidacloprid and CartapHcl are the chemical insecticides, while Neem Oil + Btk are the biological insecticides (biorationals). Hence, Neem Oil + Btk as biorationals primarily would be the best choice before Imidacloprid and CartapHcl for the ecofriendly management of major insect pests of rice. Similar recommendation has also been reported by Schoenly et al. [23], Heong et al. [24], Gallagher et al. [25], Norton et al. [26], Prakash et al. [27], Heinrichs and Muniappan [4] and Rao [28].

**Table 1. Mean Evaluation of Ecofriendly Insecticides for Major Insect Pests (Pooled of 2014 &15)*
(% Infestation (Infestation) and % Suppression of Infestation over Check (SPOC))**

Treatments	Yellow Stemborer SPOC	Common Rice Leaffolder SPOC	Brown Planthopper SPOC	Rice Hispa SPOC	Rice Earheadbug SPOC	Total Mean SPOC DAAp	Total Mean Infestation DAAp
1.CartapHcl	61.85 ^{1NS} (7.87)	53.19 ^{1NS} (7.28)	40.04 ^{2NS} (6.36)	49.59 (7.05)	69.62 (8.32)	54.86 ^{2NS} (7.38)	3.39 ^{2NS} (1.91)
2.Indoxcarb	50.63 (7.10)	39.27 (6.23)	26.87 (5.20)	37.39 (6.12)	69.02 (8.29)	44.64 (6.59)	4.16 (2.09)
3.Imidacloprid	59.45 ^{2NS} (7.73)	48.97 ^{3NS} (7.00)	41.81 ^{1NS} (6.50)	50.83 ^{1NS} (7.14)	75.95 ^{2NS} (8.71)	55.41 ^{1NS} (7.44)	3.38 ^{1NS} (1.90)
4.Chlorpyriphos	43.15 (6.55)	25.32 (5.03)	28.94 (5.42)	34.98 (5.93)	83.91 ^{1NS} (9.18)	42.71 (6.38)	4.39 (2.12)
5.Thiamethoxam	46.51 (6.78)	33.75 (5.79)	26.74 (5.21)	33.58 (5.80)	66.18 (8.11)	41.43 (6.35)	4.41 (2.14)
6.Chlorantraniliprole	52.01 (7.22)	38.99 (6.24)	33.57 (5.83)	41.93 (6.48)	63.41 (7.92)	46.72 (6.74)	4.03 (2.06)
7.Neem Oil	41.08 (6.39)	28.78 (5.36)	29.61 (5.48)	38.07 (6.17)	54.21 (7.30)	38.91 (6.18)	4.52 (2.18)
8.Btk	48.65 (6.96)	36.09 (6.00)	23.85 (4.92)	31.16 (5.58)	41.57 (6.39)	36.47 (5.99)	4.65 (2.21)
9.Neem Oil + Btk	58.97 ^{3NS} (7.69)	50.63 ^{2NS} (7.10)	38.21 ^{3NS} (6.22)	46.66 (6.83)	55.36 (7.38)	49.97 (7.04)	3.68 ^{3NS} (1.98)
10.Untreated Check	–	–	–	–	–	–	7.27 (2.73)
SE _(m)	0.15	0.15	0.14	0.02	0.20	0.04	0.03
CD _(5%)	0.45	0.46	0.41	0.05	0.59	0.11	0.08
CV _(%)	2.96	3.47	3.40	0.38	3.50	0.78	1.90

*Values in parentheses are square root transformation ($\sqrt{x + 0.5}$) for uniform sample size (Steel and Torrie [22]); 1,2,3 numerals are rank orders and NS stands for non-significant respectively; Comparison of all data respective to the non-significant lowest insect pest infestation

**Table 2. Mean Evaluation of Ecofriendly Insecticides for Major Insect Pests (Pooled of 2014 &15)*
(% Infestation (Infestation), % Suppression of Infestation over Check (SPOC) and Yield)**

Treatments	First Application (Mean)		Second Application (Mean)		Total Mean	Total Mean	Mean Yield (q/ha)
	SPOC	Infestation	SPOC	Infestation	SPOC DAAP	Infestation DAAP	
1.CartapHcl	48.96 ^{2NS} (6.98)	4.26 ^{2NS} (2.10)	60.75 ^{1NS} (7.77)	2.52 ^{1NS} (1.71)	54.86 ^{2NS} (7.38)	3.39 ^{2NS} (1.91)	35.00 ^{1NS}
2.Indoxacarb	39.58 ^{1NS} (6.22)	5.10 (2.27)	49.70 (6.96)	3.22 (1.90)	44.64 (6.59)	4.16 (2.09)	31.74
3.Imidacloprid	50.59 ^{1NS} (7.08)	4.23 ^{1NS} (2.08)	60.22 ^{2NS} (7.75)	2.58 ^{2NS} (1.73)	55.41 ^{1NS} (7.44)	3.38 ^{1NS} (1.90)	34.80 ^{2NS}
4.Chlorpyrifos	38.14 (6.03)	5.37 (2.31)	48.38 (6.81)	3.52 (1.97)	42.71 (6.38)	4.39 (2.12)	31.72
5.Thiamethoxam	36.63 (5.96)	5.35 (2.32)	46.08 (6.72)	3.43 (1.95)	41.43 (6.35)	4.41 (2.14)	31.37
6.Chlorantraniliprole	41.32 (6.39)	4.87 (2.23)	52.20 ^{4NS} (7.09)	3.18 ^{4NS} (1.90)	46.72 (6.74)	4.03 (2.06)	31.75
7.Neem Oil	33.37 (5.75)	5.41 (2.35)	44.33 (6.53)	3.53 (1.99)	38.91 (6.18)	4.52 (2.18)	31.39
8.Btk	32.11 (5.65)	5.45 (2.36)	40.42 (6.30)	3.82 (2.06)	36.47 (5.99)	4.65 (2.21)	31.18
9.Neem Oil + Btk	43.49 ^{3NS} (6.60)	4.52 ^{3NS} (2.17)	56.44 ^{3NS} (7.48)	2.83 ^{3NS} (1.80)	49.97 (7.04)	3.68 ^{3NS} (1.98)	34.28 ^{3NS}
10.Untreated Check	–	7.92 (2.83)	–	6.61 (2.63)	–	7.27 (2.73)	31.02
SE (m)	0.20	0.04	0.24	0.06	0.04	0.03	0.25
CD (5%)	0.56	0.12	0.69	0.18	0.11	0.08	0.72
CV (%)	6.98	4.05	7.74	7.26	0.78	1.90	1.33

* Values in parentheses are square root transformation ($\sqrt{x + 0.5}$) for uniform sample size (Steel and Torrie [22]); 1,2,3 numerals are rank orders and NS stands for non-significant respectively; Comparison of all data respective to the non-significant lowest insect pest infestation

**Table 3. Rank Evaluation of Ecofriendly Insecticides for Major Insect Pests (Pooled of 2014 &15)*
(Infestation/ SPOC/ Yield/ Mean)**

Rank	Infestation (%) (Lowest)	SPOC (%) (Highest)	Yield (q/ ha) (Highest)	Mean Rank
1	Imidacloprid 3.38 ^{1NS} (1.90)	Imidacloprid 55.41 ^{1NS} (7.44)	CartapHcl 35.00 ^{1NS}	Imidacloprid 1.33 ^{1NS}
2	CartapHcl 3.39 ^{2NS} (1.91)	CartapHcl 54.86 ^{2NS} (7.38)	Imidacloprid 34.80 ^{2NS}	CartapHcl 1.67 ^{2NS}
3	Neem Oil + Btk 3.68 ^{3NS} (1.98)	Neem Oil + Btk 49.97 (7.04)	Neem Oil + Btk 34.28 ^{3NS}	Neem Oil + Btk 3.00 ^{3NS}
4	Chlorantraniliprole 4.03 (2.06)	Chlorantraniliprole 46.92 (6.76)	Chlorantraniliprole 31.75	Chlorantraniliprole 4.00
5	Indoxacarb 4.16 (2.09)	Indoxacarb 44.64 (6.59)	Indoxacarb 31.74	Indoxacarb 5.00
6	Chlorpyriphos 4.39 (2.12)	Chlorpyriphos 42.71 (6.38)	Chlorpyriphos 31.72	Chlorpyriphos 6.00
7	Thiamethoxam 4.41 (2.14)	Thiamethoxam 41.43 (6.35)	Neem Oil 31.39	Thiamethoxam 7.33
8	Neem Oil 4.52 (2.18)	Neem Oil 38.91 (6.18)	Thiamethoxam 31.37	Neem Oil 7.67
9	Btk 4.65 (2.21)	Btk 36.47 (5.99)	Btk 31.18	Btk 9.00
SE_(m)	0.03	0.04	0.25	–
CD_(5%)	0.08	0.11	0.72	–
CV_(%)	1.90	0.78	1.33	–

*Values in parentheses are square root transformation ($\sqrt{x + 0.5}$) for uniform sample size (Steel and Torrie [22]); 1,2,3 numerals are rank orders and NS stands for non-significant respectively; Comparison of all data respective to the non-significant lowest insect pest infestation

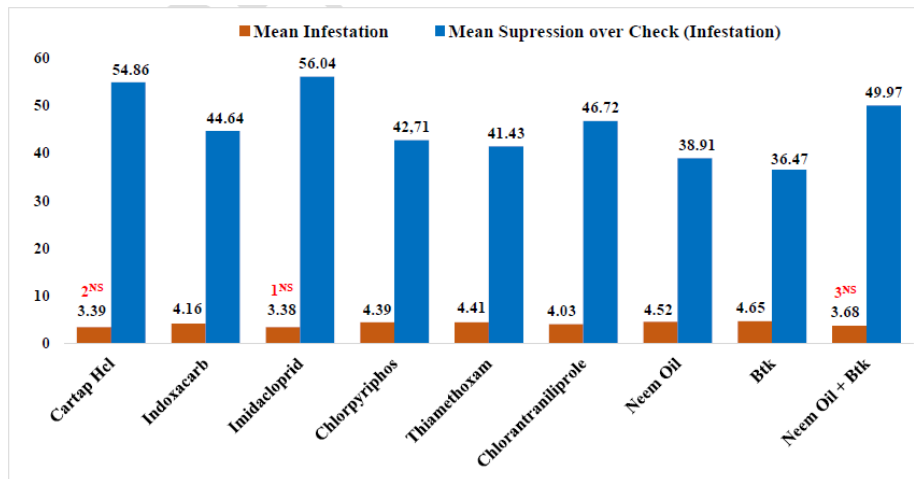


Fig. 1. Mean Evaluation of Ecofriendly Insecticides for Major Insect Pests (Pooled of 2014 & 15) (% Infestation (Infestation) and % Suppression of infestation over Check (SPOC))

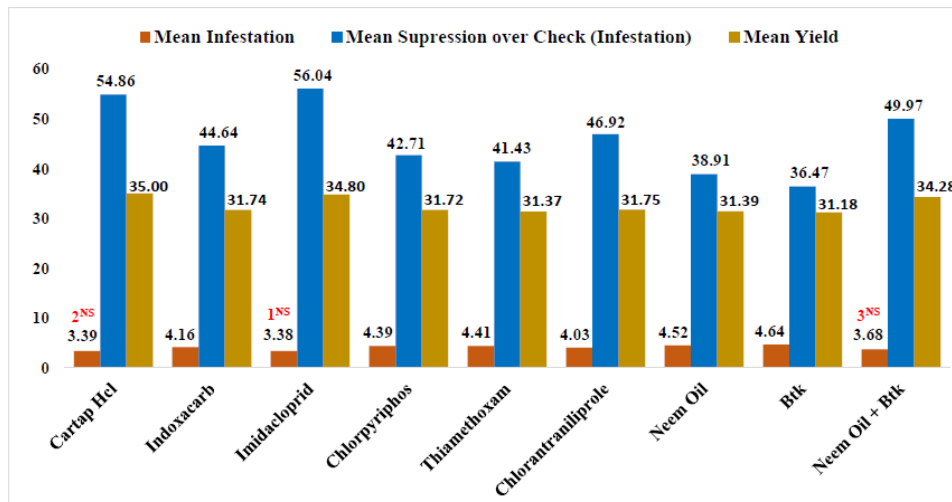


Fig. 2. Mean Evaluation of Ecofriendly Insecticides for Major Insect Pests (Pooled of 2014 & 15) (% Infestation (Infestation), % Suppression of infestation over Check (SPOC) and Yield)

4. CONCLUSION

The infestations of major insect pests of rice were observed for most serious insect pests, which were 1. Yellow stem borer (*Scirpophaga incertulus* Walker), 2. Common rice leaf folder (*Cnaphalocrosis medinalis* Guenee), 3. Brown planthopper (*Nilaparvata lugens* Stal), 4. Rice hispa (*Diuraphis armigera* Oliver), and 5. Rice earhead bug (*Leptocoris acuta* Thunberg). The inferences of suppression over check were based on non-significant ecofriendly insecticides for lowest infestation. There were 3 insecticides (CartapHcl, Imidacloprid, and Neem Oil + Btk) inference non-significant for lowest infestation and highest yield respectively. The mean ranking and inference of suppression over

check were similar to inference of non-significant ecofriendly insecticides for lowest infestation as, Imidacloprid, CartapHcl, and Neem Oil + Btk respectively. Though, all these 3 insecticides were being most effective ecofriendly insecticides as, the Imidacloprid and CartapHcl are chemical insecticides, while Neem Oil + Btk are the biological insecticides (biorationals). Hence, Neem Oil + Btk as biorationals primarily would be the best choice before Imidacloprid and CartapHcl for the ecofriendly management of major insect pests of rice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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