Bio-efficacy, persistence and residual toxicity of different insecticides against jassid *Empoasca kerri* (Pruthi) infesting soybean

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**Abstract**
An investigation was undertaken to study the bio-efficacy, persistence and residual toxicity of different insecticides viz., chlorantraniliprole 0.004 per cent, ethion 0.100 per cent, triazophos 0.050 per cent, indoxacarb 0.010 per cent, emamectin benzoate 0.001 per cent, quinalphos 0.050 per cent and profenophos 0.100 per cent against *Empoasca kerri* (Pruthi) infesting soybean at the Research Farm of the Department of Agril. Entomology, College of Agriculture, Latur (MS). The overall results concluded that all the insecticides under investigation were significantly superior over untreated control in minimizing the population of *E. kerri*. Among the treatments, profenophos 0.100 per cent was found to be the most effective insecticide in minimizing the population of *E. kerri* on soybean (3.83 and 2.60 jassids per three leaves) followed by quinalphos 0.050 per cent (4.03 and 2.90 jassids per three leaves), triazophos 0.050 per cent (4.47 and 3.50 jassids per three leaves), chlorantraniliprole 0.004 per cent (5.03 and 3.60 jassids per three leaves), indoxacarb 0.010 per cent (7.20 and 5.00 jassids per three leaves), emamectin benzoate 0.001 per cent (7.40 and 5.40 jassids per three leaves) and ethion 0.100 per cent (7.67 and 5.50 jassids per three leaves) after first and second sprays, respectively. The highest grain yield was achieved by chlorantraniliprole 0.004 per cent (34.87 q per ha) while quinalphos 0.050 per cent (1:19.72) exhibited highest incremental cost benefit ratio. The results on residual toxicity of different insecticides against *E. kerri* infesting soybean indicated that profenophos 0.100 per cent and quinalphos 0.050 per cent illustrated highest persistent toxicity index (PT) (864.67 and 873.18 and; 815.74 and 822.85, respectively) and LT50 values (6.80 and 7.02 and; 5.91 and 6.11 days, respectively) against *E. kerri* after first and second sprays as compared to other insecticides.

**Keywords:** Soybean, jassids, *Empoasca kerri* (Pruthi), bio-efficacy, residual toxicity, persistence, LT50

**Introduction**
Soybean (*Glycine max* (L.) Merrill) a miracle golden bean of the twentieth century belongs to family Leguminaceae is not only a crop of oil production but it has great therapeutic and nutritional potential. Soybean is numero uno seed legume with the unique chemical composition. Nutritionally soybean (per 100 g) is rich in energy (446 Kcal), carbohydrates (30.16 g), protein (36.49 g), fat (19.34 g), dietary fiber (9.3 g), ash (4.87 g), various vitamins, electrolytes, minerals, phyto-nutrients (USDA, 2019) [28]. High protein content of soybean seeds is great source of vegetable protein to eradicate the curse of malnutrition from the globe (ISIR, 2020) [10]. Soybean also contributes 55 per cent to the global vegetable oil production and provides about 50 per cent of the world’s protein concentrate for livestock, poultry and fish feeding (Pratap et al. 2016) [19].

Globally, soybean is one of the important cultivated on an area of 126.95 million ha with total production of 362.64 million MT and an average yield of 2860 kg per ha (USDA, 2020) [29]. In India, soybean is grown on an area of 11.13 million ha with 13.26 million MT of total production and 1192 kg per ha of an average productivity (SOPA, 2020) [27]. In Maharashtra, soybean is cultivated on area of 0.40 million ha with 0.45 million MT of total production and an average productivity of 1125 kg per ha (SOPA, 2020) [27]. Soybean has established as a major kharif crop in the rainfed agro-ecosystem of central and peninsular India. Introduction of soybean in these areas has led to a shift in the cropping system from rainy season fallow followed by post-rainy season wheat or chickpea (fallow-wheat/chickpea) to soybean followed by wheat or chickpea (soybean-wheat/chickpea) system. This has resulted in an improvement in the cropping intensity and resultant increase in the profitability per unit land area (DSR, 2015) [6].
The several biotic and abiotic stresses impede to harness the full yield potential of soybean. Moreover, the climatic adversities, disease and pest attack in soybean has appeared to be almost epidemic in nature (IISR, 2020) [10]. In India, soybean is reported to be attacked by 273 species of insects (Rawat and Kapoor, 1968) [21], out of these 20 insect pest species are most significant at national level (Singh and Singh, 1990) [28] and 13 insect pest species in respect to Marathwada region of Maharashtra (Bhamare et al. 2018) [3]. It is reported that the yield losses due to individual disease or insect or weed species ranged from 20 to 100 per cent (Sharma et al. 2014) [25].

The soybean jassid, *Empoasca kerri* (Pruthi) is emerged as one of the significant sucking insect-pests of soybean in Marathwada region of Maharashtra (Bhamare et al. 2018) [3]. The main damage is caused by the nymphs and adults of *E. kerri*. The pest remains active during vegetative growth stage, damaging the crop most severely by sucking the plant sap from tender leaves and stem. The attacked leaves turn pale and then rust red with change in appearance; the leaves also curl, dry up and fall to the ground (Khanzada et al. 2013) [12]. The occurrence of *E. kerri* is noticed with yellowing of leaf margins followed by hopper burn symptoms. The increased temperature and dry spells experiences multiplication of *E. kerri* infesting soybean (Sable et al. 2018) [22]. In case of heavy incidence of sucking pests of soybean (jassid, whitefly and thrips) yield may reduce by up to 32.16 per cent (Chaudhary et al. 2018) [9].

In India, only one chemical insecticide imidacloprid 48.00 FS is label claimed by CIB and RC against *E. kerri* on soybean. However, farmers are using several chemical insecticides against *E. kerri* which are recommended for other insect-pests of soybean. Hence, these label recommended insecticides need to be evaluated for their efficacy against *E. kerri* infesting soybean. In addition, the residual toxicity resulting from foliar application of insecticides could be of great significance in indicating an effective periods over which an insecticide could persist in biologically active stage under field conditions. Keeping this in the view, the present investigation was planned to study the bio-efficacy, persistence and residual toxicity of different insecticides against *E. kerri* infesting soybean.

**Materials and Methods**

**Bio-efficacy of different insecticides against *E. kerri* infesting soybean**

The field experiment on bio-efficacy of different insecticides against *E. kerri* infesting soybean using variety MAUS-71 was carried out in RBD with eight treatments including untreated control replicated three times at the Research Farm of Department of Agril. Entomology, College of Agriculture, Latur (Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani) (MS)-India during *Khurif* 2015. Soybean was cultivated with all recommended package of practices recommended by VNMKV, Parbhani for raising the crop except insect-pest management. The first application of insecticide spray was done at ETL. The observation on total number of *E. kerri* was recorded on top, middle and bottom leaves of five randomly selected plants from each treatment at one day before treatment and 1, 3, 7 and 14 days after first and second application of insecticides. The data on jassid population were transformed into square root transformation before statistical analysis to know the significance of difference among different treatments. After crop attained maturity, it was harvested and weight of grain per plot was recorded separated in each treatment. Plot wise yield was computed on hectare basis for statistical interpretation. The economics of the treatment was also worked out based on grain yield and cost of protection. Based on cost of protection and gross profit, the incremental cost benefit ratio (ICBR) was worked out. The data in respect of bio-efficacy and economics of different insecticides against *E. kerri* infesting soybean were statistically analyzed by standard ‘analysis of variance’. The null hypothesis was tested by ‘F’ test of significance at 5 per cent level (Gomez and Gomez, 1984) [9].

**Persistence and residual toxicity of different insecticides against *E. kerri* infesting soybean**

The toxicity of different insecticides was studied against nymphs of *E. kerri* at 1, 3, 7 and 14 days after first and second application of insecticides. Due care was taken to cover the entire plant while application of insecticides. The required numbers of leaves or trifoliates receiving application of insecticides were tagged for investigations on residual toxicity of insecticides. The number of test insects used for the bioassay studies were ten for each treatment in each replication. The tagged leaves or trifoliates were brought into the laboratory at the prescribed day intervals. The treated leaves or trifoliates were kept into plastic containers separately. The stalk of leaf or trifoliate was covered with moistened cotton wool in order to retain their turgidity for 24 hours. The nymphs of jassid were slightly disturbed allowing them to draw their proboscis from the host plant. Then the nymphs of *E. kerri* collected from unsprayed soybean plots and released on treated leaves or trifoliates which were kept in the plastic container. The numbers of dead or moribund jassids were counted after 24 hours of exposure. Similarly control mortality of jassids was also observed by releasing them on untreated substrate of soybean plant.

**Correction on percentage mortality**

The observations on mortality of jassids were converted into percentage mortality. The average percentage mortality was calculated from the observations in 3 replications. The observations on percentage mortality thus obtained were corrected with Abbott’s (1925) [1] formula as follows.

\[
P = \frac{T - C}{100 - C} \times 100
\]

Where as, \(P\) = Corrected percentage mortality, \(T\) =Percentage mortality in treatment, \(C\) = Percentage mortality in control.

**LT\(_{50}\) values**

The values of LT\(_{50}\) (time required to give 50 per cent mortality) for different insecticides applied on soybean plants were calculated by using software of Probit analysis as suggested by Finney (1971) [17].

**PT values**

The product (PT) of average residual toxicity (T) and the period (P) for which the toxicity persisted was used as an index of persistent toxicity. The values of corrected percentage mortalities at various specified periods were added. This sum was then divided by number of observations in order to obtain residual toxicity (T). The procedure followed by Saini (1959) [23] and elaborated further by Pradhan (1967) [18], Sarup *et al* (1970) [24] and; Dake and Bhamare (2019) [5] was utilized.
**Results and Discussion**

**Effect of different insecticides on population of *Empoasca kerri Pruthi* infesting soybean**

The data pertaining to effect of different insecticides on population of *E. kerri* infesting soybean after first and second spray are presented in Table 1. The results revealed that all the insecticides were found to be significantly superior over untreated control in reducing population of soybean jassid at 1, 3, 7 and 14 days after first and second application of insecticides.

| Treatments      | Mean number of jassid per three leaves | Main grain yield q/ha | ICBR |
|-----------------|---------------------------------------|-----------------------|------|
|                 | One day before spray                  | Days after spraying   | One day before spray | Days after spraying |                                          |                  |
|                 | 1         | 3    | 7     | 14    | 1         | 3    | 7     | 14    |                                          |                  |
| Profenophos     | 9.20      | 3.27 | 3.37  | 3.47  | 3.83      | 8.83  | 2.03  | 2.11  | 2.37  | 2.60 |
| 0.100 per cent  | (3.02)*   | (1.80) | (1.83) | (1.86) | (1.95)    | (2.97)* | (1.41) | (1.45) | (1.53) | (1.61) |
| Triazophos      | 10.47     | 3.53 | 3.73  | 4.00  | 4.47      | 8.01  | 2.15  | 2.23  | 2.30  | 3.50 |
| 0.050 per cent  | (3.23)    | (1.85) | (1.92) | (2.07) | (2.23)    | (2.82) | (1.46) | (1.49) | (1.72) | (1.86) |
| Quinalphos      | 9.67      | 3.40 | 3.60  | 3.80  | 4.03      | 8.01  | 2.10  | 2.17  | 2.50  | 2.90 |
| 0.050 per cent  | (3.10)    | (1.84) | (1.89) | (1.96) | (1.99)    | (2.94) | (1.44) | (1.47) | (1.57) | (1.70) |
| Indoxacarb      | 9.67      | 4.67 | 4.80  | 6.07  | 7.20      | 9.20  | 4.00  | 4.07  | 4.53  | 5.00 |
| 0.010 per cent  | (3.10)    | (2.15) | (2.19) | (2.46) | (2.68)    | (3.03) | (1.99) | (2.01) | (2.12) | (2.23) |
| Ethion           | 10.53     | 4.93 | 5.13  | 6.42  | 7.67      | 10.03 | 4.47  | 4.50  | 5.00  | 5.50 |
| 0.100 per cent  | (3.24)    | (2.22) | (2.26) | (2.54) | (2.76)    | (3.16) | (2.11) | (2.11) | (2.23) | (2.34) |
| Chlorantraniliprole | 9.73    | 3.57 | 3.93  | 4.67  | 5.03      | 9.70  | 2.23  | 3.10  | 3.30  | 3.60 |
| 0.004 per cent  | (3.11)    | (1.87) | (1.98) | (2.15) | (2.23)    | (2.90) | (1.49) | (1.76) | (1.81) | (1.89) |
| Emamectin benzoate | 10.00  | 4.80 | 5.07  | 6.27  | 7.40      | 9.35  | 4.07  | 4.10  | 4.90  | 5.40 |
| 0.001 per cent  | (3.15)    | (2.19) | (2.25) | (2.49) | (2.72)    | (3.05) | (2.01) | (2.02) | (2.21) | (2.32) |
| Untreated Control | 10.87  | 10.93 | 11.00 | 11.45 | 11.70     | 11.60 | 11.73 | 11.77 | 12.00 | 12.40 |
|                  | (3.29)    | (3.20) | (3.33) | (3.33) | (3.38)    | (3.40) | (3.30) | (3.42) | (3.46) | (3.51) |
| S.E ±           | -         | 0.06 | 0.04  | 0.06  | 0.07      | -     | 0.05  | 0.04  | 0.04  | 0.05 |
| C.D. at 5 per cent | NS      | 0.20 | 0.14  | 0.18  | 0.23      | NS    | 0.16  | 0.13  | 0.13  | 0.17 |
| C.V.            | -         | 5.30 | 3.67  | 4.40  | 5.44      | -     | 4.98  | 3.90  | 3.72  | 4.52 |

* Figures in parentheses are angular transformed values
N.S.: Non-significant

### First spray

At one day after first spray, significantly minimum population of jassid (3.27 per three leaves) was recorded from the plots treated with profenophos 0.100 per cent followed by quinalphos 0.050 per cent (3.40 per three leaves), triazophos 0.050 per cent (3.53 per three leaves), chlorantraniliprole 0.004 per cent (3.57 per three leaves). All these treatments proved significantly superior and statistically at par with each other. The next effective treatments were indoxacarb 0.010 per cent (4.67 jassids per three leaves), emamectin benzoate 0.001 per cent (4.80 jassids per three leaves) and ethion 0.100 per cent (4.93 jassids per three leaves).

At three days after first spray, profenophos 0.100 per cent recorded significantly lowest population of jassid (3.37 per three leaves) followed by quinalphos 0.050 per cent (3.60 per three leaves) and triazophos 0.050 per cent (3.73 per three leaves). All these treatments were found to be statistically at par with each other. The subsequent order of effectiveness was chlorantraniliprole 0.004 per cent (3.93 jassids per three leaves), indoxacarb 0.010 per cent (4.80 jassids per three leaves), emamectin benzoate 0.001 per cent (5.07 jassids per three leaves) and ethion 0.100 per cent (5.13 jassids per three leaves).

At seven days after first spraying, profenophos 0.100 per cent evidenced significantly effective treatment in minimizing jassid population (3.47 per three leaves) which was followed by quinalphos 0.050 per cent (3.80 per three leaves). Both these treatments were found to be significantly superior and statistically at par with each other. Subsequently effective treatments in reducing jassid population on soybean were triazophos 0.050 per cent (4.00 per three leaves), chlorantraniliprole 0.004 per cent (4.67 per three leaves), indoxacarb 0.010 per cent (6.07 per three leaves), emamectin benzoate 0.001 per cent (6.27 per three leaves) and ethion 0.100 per cent (6.42 per three leaves).

At 14 days after first spraying, significantly lowest population of jassid was noticed in profenophos 0.100 per cent (3.83 per three leaves) followed by quinalphos 0.050 per cent (4.03 per three leaves). Both these treatments were statistically on par with each other. Triazophos 0.050 per cent, chlorantraniliprole 0.004 per cent, indoxacarb 0.010 per cent, emamectin benzoate 0.001 per cent and ethion 0.100 per cent observed to be subsequently effective insecticides with 4.47, 5.03, 7.20, 7.40 and 7.67 jassids per three leaves, respectively.

### Second spray

At one day after second spray, significantly minimum population of jassid (2.03 per three leaves) was recorded from the plots treated with profenophos 0.100 per cent followed by quinalphos 0.050 per cent (2.10 per three leaves), triazophos 0.050 per cent (2.15 per three leaves) and chlorantraniliprole 0.004 per cent (2.23 per three leaves). All these treatments were found to be statistically at par with each other. The subsequently effective treatments were indoxacarb 0.010 per cent (4.00 jassids per three leaves), emamectin benzoate 0.001 per cent (4.07 jassids per three leaves) and ethion 0.100 per cent (4.47 jassids per three leaves).

At three days after second spray, profenophos 0.100 per cent recorded significantly lowest population of jassid (2.11 per three leaves) followed by quinalphos 0.050 per cent (2.17 per three leaves), triazophos 0.050 per cent (2.23 per three leaves). All these treatments were found to be equally effective in reducing jassid population. The subsequent order of effectiveness was chlorantraniliprole 0.004 per cent (3.10 jassids per three leaves), indoxacarb 0.010 per cent (4.07 jassids per three leaves), emamectin benzoate 0.001 per cent

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Effect of different insecticides on grain yield and incremental cost benefit ratio (ICBR) of soybean

The results in respect of effect of different insecticides on grain yield and ICBR of soybean are presented in Table 1. The data regarding grain yield of soybean revealed that all the treatments were statistically significant in increasing grain yield over untreated control. The grain yield of soybean due to different treatments varied from 12.09 to 34.87 q per ha. The significantly highest grain yield of soybean was recorded in chlorantraniliprole 0.004 per cent (34.87 q per ha) which was followed by emamectin benzoate 0.001 per cent (31.55 q per ha), indoxacarb 0.010 percent (31.25 q per ha), quinalphos 0.050 per cent (29.63 q per ha), triazophos 0.050 per cent (29.06 q per), profenophos 0.100 per cent (20.46 q per ha) and ethion 0.100 per cent (16.43 q per ha). However, the lowest grain yield (12.09 q per ha) was registered in untreated control. The result of present investigation are in harmony with the findings of Patil et al. (2014) [15] who reported that significantly highest seed yield of soybean (19.88 q per ha) was obtained in chlorantraniliprole (30 g a.i. per ha). Kothalkar et al. (2015) [14] revealed that emamectin benzoate 5 SG at the rate of 0.02 per cent + triazophos 40 EC at the rate of 0.06 per cent, emamectin benzoate 5 SG at the rate of 0.02 per cent, triazophos 40 EC at the rate of 0.06 per cent and flubenimidamide 20 WG at the rate of 0.01 per cent + triazophos 40 EC at the rate of 0.06 per cent obtained comparatively highest yield. Patil et al. (2015) [16] found that emamectin benzoate 1.9 EC at the rate of 200 ml per ha and indoxacarb 14.5 SC at the rate of 500 ml per ha obtained higher yield of soybean. Patil and Phad (2014) [17] highest soybean seed yield was noticed in triazophos 20 EC, chlorantraniliprole 18.5 SC and indoxacarb 14.5 SL.

The data on the average percentage mortality of nymphs of E. kerri on soybean leaves receiving first and second spray are presented in Table 2.

Table 2: Persistence of different insecticides on leaves of soybean applied as first and second spray against E. kerri

| Treatments                      | Corrected percentage mortality after different intervals (days) | P | T | PT | R.E. | O.R.E. | Corrected percentage mortality after different intervals (days) | P | T | PT | R.E. | O.R.E. |
|---------------------------------|---------------------------------------------------------------|---|---|----|-----|-------|---------------------------------------------------------------|---|---|----|-----|-------|
| Profenophos 0.100 per cent      | 92.82                                                        | 71.41 | 58.63 | 24.19 | 61.76 | 14 | 864.67 | 1.55 | 1    | 93.07 | 75.05 | 57.17 | 24.19 | 62.37 | 473.18 | 39 | 1 |
| Triazophos 0.050 per cent       | 85.76                                                        | 64.34 | 51.78 | 20.68 | 55.64 | 14 | 778.96 | 1.39 | 3    | 86.24 | 67.88 | 50.00 | 20.68 | 56.20 | 486.30 | 25 | 3 |
| Quinalphos 0.050 per cent       | 89.29                                                        | 67.88 | 55.22 | 20.68 | 58.26 | 14 | 815.74 | 1.46 | 2    | 89.65 | 71.13 | 53.64 | 20.68 | 50.77 | 422.85 | 31 | 2 |
| Indoxacarb 0.010 per cent       | 78.58                                                        | 57.17 | 44.88 | 17.26 | 49.42 | 14 | 692.58 | 1.24 | 5    | 82.73 | 60.70 | 42.93 | 17.26 | 50.98 | 472.60 | 13 | 5 |
| Ethion 0.100 per cent           | 71.41                                                        | 46.46 | 27.61 | 13.85 | 39.83 | 14 | 557.65 | 1.00 | 7    | 75.90 | 53.64 | 35.76 | 13.85 | 44.78 | 427.02 | 10 | 7 |
| Chlorantraniliprole 0.004 per cent | 82.11                                                    | 57.17 | 48.32 | 17.26 | 52.12 | 14 | 714.00 | 1.28 | 4    | 86.24 | 64.34 | 46.46 | 17.26 | 53.57 | 450.05 | 19 | 4 |
| Emamectin benzoate 0.001 percent | 75.85                                                  | 54.71 | 37.95 | 17.26 | 46.44 | 14 | 650.19 | 1.16 | 6    | 79.31 | 57.17 | 39.29 | 13.85 | 47.40 | 463.67 | 1.05 | 6 |

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First spray

The result of first spray evident that profenophos 0.100 per cent and quinalphos 0.050 per cent concentration showed comparatively high percentage mortality of nymph of E. kerri to the tune of 24.19 and 20.68 per cent, respectively at 14 days after spraying. On the basis of PT values the descending order of persistent toxicity was profenophos 0.100 per cent (> triazophos 0.050 per cent (786.80) > chlorantraniliprole 0.004 per cent (750.05) > indoxacarb 0.010 per cent (712.60) > emamectin benzoate 0.001 per cent (663.67) > ethion 0.100 per cent (627.02)).

The data pertaining to LT₅₀ values of insectsicides against nymphs of E. kerri on soybean leaves are presented in Table 3.

The data revealed that profenophos 0.100 per cent showed highest LT₅₀ value (6.80 days) against the nymphs of jassid on soybean following by quinalphos 0.050 per cent and was the most efficacious insecticide against nymphs of E. kerri on soybean leaves. On spraying. On the basis of PT values the descending order of persistent toxicity was profenophos 0.100 per cent (> quinalphos 0.050 per cent (5.91) > triazophos 0.050 per cent (5.32) > chlorantraniliprole 0.004 per cent (4.37) > indoxacarb 0.010 per cent (4.02) > emamectin benzoate 0.001 per cent (3.38) > ethion 0.100 per cent (2.72).

Second spray

The result of second spray evident that profenophos 0.100 per cent and quinalphos 0.050 per cent concentration showed comparatively high percentage mortality of nymphs of E. kerri to the tune of 24.19 and 20.68 per cent, respectively at 14 days after spraying. On the basis of PT values the descending order of persistent toxicity was profenophos 0.100 per cent (> triazophos 0.050 per cent (6.80) > quinalphos 0.050per cent (5.91) > triazophos 0.050 per cent (5.32)) > chlorantraniliprole 0.004 per cent (4.37) > indoxacarb 0.010 per cent (4.02) > emamectin benzoate 0.001 per cent (3.38) > ethion 0.100 per cent (2.72).

Table 3: Relative efficacy of different insecticides against E. kerri on soybean leaves applied as first and second spray

| Treatments              | Heterogenei ty | Regression Equation (y =…….) | Log LT₅₀± S.Em (days) | LT₅₀ (days) | R.E. | D.R.E. | Heterogenei ty | Regression Equation (y =…….) | Log LT₅₀± S.Em (days) | LT₅₀ (days) | R.E. | D.R.E. |
|-------------------------|----------------|-------------------------------|------------------------|-------------|------|--------|----------------|-------------------------------|------------------------|-------------|------|--------|
| Profenophos 0.100 per cent | 2 0.444 | y=0.1032x + 1.3863 | 0.8330±0.1363 | 6.80 | 1.31 | 20.69 | 2.50 | 1 | 2 0.403 | y=0.1093x + 1.8748 | 0.8463±0.1342 | 7.02 | 1.31 | 20.84 | 2.14 | 1 |
| Triazophos 0.050 per cent | 2 0.436 | y=0.0792x + 1.6061 | 0.7266±0.1462 | 5.32 | 1.21 | 16.55 | 1.95 | 3 | 2 0.457 | y=0.1262x + 1.6152 | 0.7420±0.1447 | 5.52 | 1.73 | 17.05 | 1.68 | 5 |
| Quinalphos 0.050 per cent | 2 0.549 | y=0.0231x + 1.4277 | 0.7718±0.1383 | 5.91 | 1.23 | 17.15 | 2.17 | 2 | 2 0.552 | y=0.1659x + 1.7646 | 0.7860±0.1367 | 6.11 | 1.24 | 17.52 | 1.86 | 2 |
| Indoxacarb 0.010 per cent | 2 0.406 | y=0.0556x + 1.5293 | 0.6047±0.1554 | 4.02 | 0.81 | 6.51 | 1.47 | 5 | 2 0.341 | y=0.0294x + 1.5799 | 0.6408±0.1443 | 4.37 | 1.06 | 11.52 | 1.33 | 5 |
| Ethion 0.100 per cent | 2 0.188 | y=0.1124x + 1.7635 | 0.4358±0.1704 | 2.72 | 1.00 | 7.94 | 1.00 | 7 | 2 0.318 | y=0.0752x + 1.4859 | 0.5163±0.1551 | 3.28 | 0.89 | 7.94 | 1.00 | 7 |
| Chlorantraniliprole 0.004 per cent | 2 0.556 | y=0.0972x + 2.0102 | 0.6410±0.1489 | 4.37 | 1.08 | 12.28 | 1.85 | 4 | 2 0.442 | y=0.0763x + 1.7000 | 0.6908±0.1365 | 4.90 | 1.09 | 12.52 | 1.49 | 4 |
| Emamectin benzoate 0.001 per cent | 2 0.148 | y=0.0324x + 1.4422 | 0.5301±0.1623 | 3.38 | 0.95 | 9.03 | 1.60 | 6 | 2 0.440 | y=0.0197x + 1.5676 | 0.5719±0.1459 | 3.73 | 0.95 | 9.01 | 1.13 | 6 |

Conclusion

The overall results concluded that profenophos 0.100 per cent was the most efficacious insecticide against E. kerri infesting soybean followed by quinalphos 0.050 per cent and triazophos 0.050 per cent. Similarly, the higher residual toxicity was exhibited by these insecticides against nymph of E. kerri on soybean.

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