BIO-EFFICACY OF NEWER INSECTICIDES AGAINST SUCKING PEST COMPLEX OF CASTOR (*Ricinus communis* L*innaeus*)

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ABSTRACT

A field experiment on bio-efficacy of newer insecticides against sucking pest complex of castor (R. communis) was conducted at Main Castor and Mustard Research Station, Sadarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, during 2012-13. Among the various insecticides tested, imidacloprid 0.006 per cent was the most effective insecticide against leafhopper and whitefly, while thiomethoxam 0.01 per cent was found most effective insecticide against thrips. Imidacloprid 0.006 per cent registered the lowest population of leafhopper and whitefly and recorded the highest yield of castor.

KEY WORDS: Bio-efficacy, castor, sucking pest complex

INTRODUCTION

Castor, Ricinus communis Linnaeus, is an important industrially valued non edible oilseed crop in the world belongs to the family Euphorbiaceae. *It is being cultivated in more than 30 different countries of the world on commercial* scale. *Among these, Brazil, India, China, USSR, Thailand and Philippines are* the *most important countries, as they account for 90 per cent of the world* production (Anonymous, 2012). Castor is grown on a total area of 1.2 m ha with an average production of 1.6 m tonnes, and productivity of 950 kg/ha (FAOSTAT 2008). India is the world leader in castor, producing nearly two-thirds of the total global production *followed by Brazil. India occupies the next best position in the world's castor market earning foreign exchange by exporting major part of its total produce and thus, plays an important role in agricultural economy of our country.* I*n India, Gujarat, Andhra Pradesh and Rajasthan are the major castor producing states (84 % of total area), followed by Chhattisgarh (9.1 %), Karnataka (2.3 %), Orissa (2 %) and Tamil Nadu (0.6 %). Total area under castor crop in India for the year 2011-12 is 11.50 lakh hectare, out of which Gujarat occupies 6.97 lakh hectare* with an average yield of 1760 kg/ha (Anonymous, 2012). *Gujarat is the largest producer in the country with Mehsana, Banaskantha, Ahmedabad, Kachchh, Gandhinagar and Sabar-kantha are the major castor producing districts in the state (Anonymous, 2011).* The seed yield losses in castor due to insect pests varied

widely depending on the season, severity of major pests and with variety/hybrids (Anonymous, 2006). The yield losses to the tune of 12.4 to 15 per cent were reported due to sucking pests in Gujarat (Khanpara and Patel, 2002). Castor is attacked by number of insect pest right from sowing to harvesting. Among these, sucking pests *viz*., leafhoppers, whiteflies and thrips played an important role in early stages resulting in extensive losses in the grain yield. Considering the seriousness of the problem, newer insecticides were evaluated in the present experiment.

MATERIALS AND METHODS

With a view to evaluate the bio-efficacy of newer insecticides against sucking pest complex, a field experiment was conducted following Randomized Block Design with ten treatments and three replications at Main Castor and Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during 2012-13. The plot having uniform size (Gross: 6.00 m x 4.50 m and Net: 5.00 m x 2.70 m), with a spacing of 90 cm x 60 cm were selected and used for the study. Various insecticides were applied at respective dose with the help of knapsack sprayer. The first application of insecticidal treatment was made with highest population stage occurs in the field. The second spray was given at fifteen days interval after first spray. For recording observations, five plants were selected and tagged with the help of white plastic label for each treatment. Number of population of leafhopper, thrips and whitefly were counted and recorded from the five tagged selected plants. Population was counted before spraying and 24, 48, 72 hrs and 7 days after spraying. Yield of castor from the net plot was recorded and weighted with the help of electronic weighing balance and converted in to kg/ha. The data, thus, obtained were subjected to statistical analysis for drawing meaningful conclusion.

RESULTS AND DISCUSSION

The results on sucking pest population before and after spray are presented and discussed here as under.

Leafhopper, *E. flavescens*

The data on leafhopper population recorded after different intervals of application are summarized in Table 1 and Figure 1 & 2. The data on leafhopper population revealed that the leafhopper population ranged from 2.03 to 2.53 per leaf and differences among various plots were non-significant before spray, which indicated a uniform leafhopper population equally distributed in experimental plots. The mean leafhopper population (Table 1 and Figure 1) after 24 hrs of application of insecticides revealed that plots treated with imidacloprid 0.006 per cent recorded lowest leafhopper population of (0.67/ leaf) which was at par with dimethoate 0.03 per cent, acephate 0.075 per cent and thiomethoxam 0.01 per cent, as they registered 0.75, 0.78 and 1.01 leafhoppers per leaf, respectively. The botanicals *viz.*, NSKE 5 per cent, achook 1500 ppm and neem oil 3000 ppm registered 1.16, 1.19 and 1.22 leafhopper per leaf, respectively, which were less effective compare to chemicals in reducing the leafhopper population. The spray with *Verticillium lecani* 10^8 cfu/ml and fipronil 0.0025 per cent were least effective with a maximum population of 1.27 and 1.30 leafhoppers per leaf, respectively, but found superior over control (2.09 leafhoppers/leaf). The population of leafhopper after 48 hrs of application of insecticides (Table 1 and Figure 1) indicated minimum leafhopper population of 0.44 per leaf in the plots treated with imidacloprid 0.006 per cent, indicating most effective treatment in lowering leafhopper population. However, it was at par with

dimethoate 0.03 per cent, acephate 0.075 per cent and thiomethoxam 0.01 per cent, as they registered 0.69, 0.73 and 0.85 leafhoppers per leaf, respectively. The treatment with NSKE 5 per cent, achook 1500 ppm, neem oil 3000 ppm and fipronil 0.0025 were found moderately effective with a population of 0.99, 0.99, 1.06 and 1.16 leafhopper per leaf. The treatment with *Verticillium lecani* 10^8 cfu/ml was found least in reducing the leafhopper population. Similar trend was observed 72 hrs after application also (Table 1 and Figure 1). Imidacloprid 0.006 per cent was the most effective chemical with minimum leafhopper population of 0.27 per leaf and it was at par with dimethoate 0.03 per cent, acephate 0.075 per cent and thiomethoxam 0.01 per cent, as they exhibited 0.48, 0.56 and 0.58 leafhopper populations per leaf, respectively. The treatment with NSKE 5 per cent, achook 1500 ppm, neem oil 3000 ppm and fipronil 0.0025 per cent were found moderately effective with 0.80, 0.80, 0.87 and 1.04 leafhoppers per leaf. The treatment with entomogenous fungi *Verticillium lecani* 10^8 cfu/ml was least effective as compare to the other treatments with 1.14 leafhoppers per leaf, after 72 hrs of application, but showed superiority over control (2.16 leafhopper/leaf). Seven days after first spray, the lowest leafhopper population was recorded in imidacloprid 0.006 per cent (0.40 leafhopper/leaf) and it was at par with dimethoate 0.03 per cent, acephate 0.075 per cent and thiomethoxam 0.01 per cent, as they registered 0.58, 0.80 and 0.89 leafhoppers per leaf, respectively. The treatment with NSKE 5 per cent, achook 1500 ppm and neem oil 3000 ppm were found comparatively less effective with population of 1.06, 1.09 and 1.09 leafhoppers per leaf. The treatment fipronil 0.0025 per cent and *Verticillium lecani* 10^8 cfu/ml was least effective compare to other treatments with maximum population of 1.30 and 1.35 leafhoppers per leaf, respectively.

The second spraying was carried out 15 days after first spray and the population of leafhoppers measured after 24 hrs of second spray is presented in Table 1 and Figure 2. A perusal of the data revealed that imidacloprid 0.006 per cent was the most effective treatment with minimum leafhopper population per leaf (0.35) and it was at par with dimethoate 0.03 per cent (0.54) and acephate 0.075 per cent (0.54). The treatments with thiomethoxam 0.01 per cent, NSKE 5 per cent and fipronil 0.0025 per cent also recorded low leafhopper population of 0.78, 0.78 and 0.80 per leaf. The treatment with neem oil 3000 ppm and achook 1500 ppm was less effective with a population of 0.82 and 0.85 per leaf, respectively. The plot treated with *Verticillium lecani* 10^8 cfu/ml recorded significantly highest leafhopper population of 0.92 per leaf, which is least effective but effective than control (2.06 leafhopper/leaf). After 48 hrs of second spray, minimum leafhopper population was recorded in imidacloprid 0.006 per cent (0.27leafhopper/leaf), and it was at par with acephate 0.075 per cent (0.50) and dimethoate 0.03 per cent (0.52). The treatments with thiomethoxam 0.01 per cent and fipronil 0.0025 per cent also found effective with less leafhopper population of 0.67 and 0.67 per leaf, respectively. The treatment with NSKE 5 per cent, achook 1500 ppm and neem oil 3000 ppm was moderately effective as the population of leafhopper per leaf were medium in these treatments after 48 hrs. The remaining treatment of *Verticillium lecani* 10^8 cfu/ml was least effective as it registered maximum leafhopper population of 0.85 per leaf. The result of mean leafhopper population after 72 hrs of application indicated that

imidacloprid 0.006 per cent was the most effective in reducing leafhopper population (0.16 per leaf) and it was at par with dimethoate 0.03 per cent (0.17), acephate 0.075 per cent (0.31) and thiomethoxam 0.01 per cent (0.42). The treatment with NSKE 5 per cent, neem oil 3000 ppm, fipronil 0.0025 per cent and achook 1500 ppm were found moderately effective with a population of 0.48, 0.48, 0.50, 0.50 per leaf, respectively. *Verticillium lecani* 10^8 cfu/ml was least effective with maximum leafhopper population of 0.73 per leaf. Seven days after application of insecticides, minimum leafhopper population was observed in imidacloprid 0.006 per cent (0.27), followed by dimethoate 0.03 per cent (0.29), acephate 0.075 per cent (0.52) and thiomethoxam 0.01 per cent (0.62) which were at par in its efficacy. The treatment with NSKE 5 percent (0.71), achook 1500 ppm (0.73), neem oil 3000 ppm (0.73) and fipronil 0.0025 per cent (0.73) was found moderately effective. The treatment *Verticillium lecani* 10^8 cfu/ml was least effective as it recorded highest leafhopper population of 0.96 per leaf, one week after second spray, but showed good results over control (2.06 leafhopper/leaf).

Thrips, *S. dorsalis*

The data on population of thrips recorded after different intervals of application of various insecticides, botanicals and other formulation are summarized in Table 2 and Figure 3 and 4.

The results presented in Table 2 and Figure 3 revealed that thrips population ranged from 2.03 to 2.32 thrips per spike and differences among various plots were non-significant indicating a uniform population in all the treatments before application. The mean thrips population after 24 hrs of application of insecticides revealed that thiomethoxam 0.01 per cent was most effective treatment recorded minimum thrips population of 0.44 per spike among the treatments. However, it was at par with acephate 0.075 per cent, imidacloprid 0.006 per cent and dimethoate 0.03 per cent as they registered 0.62, 0.69 and 0.82 thrips per spike, respectively. The treatment with fipronil 0.0025 per cent was moderately effective (1.01) in reducing thrips population. The botanicals *viz.*, NSKE 5 per cent, achook 1500 ppm and neem oil 3000 ppm were less effective in regulating thrips population (1.04, 1.19 and 1.22 thrips per spike, respectively). The remaining treatment, *Verticillium lecani* 10^8 cfu/ml was found least effective with a maximum thrips population of 1.24 per spike. The highest population of thrips was found in control plot (2.16 thrips/spike). The data on thrips population 48 hrs after application of insecticides indicated minimum thrips population (0.35 per spike) in the plots treated with thiomethoxam 0.01 per cent which was the most effective among the treatments. However, it was at par with acephate 0.075 per cent and imidacloprid 0.006 per cent with population count of 0.58 and 0.64 thrips per spike, respectively. The treatment dimethoate 0.03 per cent (0.71) and fipronil 0.0025 percent (0.94) were moderately effective. The botanicals *viz.*, NSKE 5 per cent, achook 1500 ppm, neem oil 3000 ppm were less effective with a thrips population of 0.99, 1.11 and 1.14 thrips per spike, respectively. The fungus treatment *Verticillium lecani* 10^8 cfu/ml was not found effective on compared to other treatments which registered highest thrips population. More or less similar trend was observed 72 hrs after application. The thiomethoxam 0.01 per cent was most effective with least thrips count of 0.21 per spike. However, it was at par with acephate 0.075 per cent, imidacloprid 0.006 per cent and dimethoate 0.03 per cent as they registered 0.46, 0.50 and 0.54 thrips per

spike, respectively. The treatment with fipronil 0.0025 per cent (0.80) was moderately effective. The treatment with NSKE 5 per cent, neem oil 3000 ppm and achook 1500 ppm were less effective with a thrips population of 0.87, 0.96 and 1.04 per spike, respectively. The entomogenous fungus formulation, *Verticillium lecani* 10^8 cfu/ml was least effective with maximum thrips count of 1.06 per spike. The population of thrips seven days after application was minimum in thiomethoxam 0.01 per cent (0.29thrips/spike) which was at par with imidacloprid 0.006 per cent (0.60), acephate 0.075 per cent (0.64) and dimethoate 0.03 per cent (0.71). The treatment with fipronil 0.0025 per cent (1.04) was moderately effective. The spray with NSKE 5 per cent, achook 1500 ppm and neem oil 3000 ppm were less effective with a population of 1.11, 1.16 and 1.22 thrips per spike. The treatment *Verticillium lecani* 10^8 cfu/ml was least effective compared to other treatments with thrips count of 1.30 per spike, while it was found superior over control (2.12 thrips/spike).

The data on the population of thrips presented in Table 2 and Figure 4 revealed that thrips population ranged from 1.09 to 1.96 per spike, among the various plots. The mean thrips population after 24 hrs of application of insecticides revealed that thiomethoxam 0.01 per cent was most effective, with lowest thrips population of 0.24 per spike. However, it was at par with imidacloprid 0.006 per cent, acephate 0.075 per cent and dimethoate 0.03 per cent with a thrips count of 0.31, 0.38 and 0.4 per spike, respectively. The treatment fipronil 0.0025 per cent (0.89) was found moderately effective. The botanical formulation *viz.*, achook 1500 ppm, neem oil 3000 ppm and NSKE 5 per cent were not effective as compare to rest of the chemical. The fungal formulation, *Verticillium lecani* 10^8 cfu/ml was least effective with highest thrips population per spike (0.99), but showed its superiority over control (2.06 thrips/spike). After 48 hrs of sparying of insecticides, minimum thrips population was observed in the plots treated with thiomethoxam 0.01 per cent, the most effective chemical among different treatments and reported lowest thrips per spike (0.17). However, it was at par with imidacloprid 0.006 per cent (0.22), acephate 0.075 per cent (0.31) and dimethoate 0.03 per cent (0.38). The effectiveness of botanicals *viz.*, achook 1500 ppm, neem oil 3000 ppm, NSKE 5 per cent and fipronil 0.0025 per cent were moderate with a population of 0.58, 0.71, 0.75 and 0.80 thrips per spike. The treatment *Verticillium lecani* 10^8 cfu/ml recorded highest thrips per spike indicating its least effectiveness in reducing the thrips population on castor. After 72 hrs of application, the effectiveness of different chemicals showed more or less similar trend (Table 2 and Figure 4). The thiomethoxam 0.01 per cent was most effective with lowest thrips population of 0.12 per spike. However, it was at par with imidacloprid 0.006 per cent (0.17), acephate 0.075 per cent (0.24) and dimethoate 0.03 per cent (0.31). The treatment with achook 1500 ppm (0.46), neem oil 3000 ppm (0.60), NSKE 5 per cent (0.64) and fipronil 0.0025 per cent (0.67) were less effective. The fungal formulation of *Verticillium lecani* 10^8 cfu/ml was not effective in lowering the thrips population on castor. The lowest thrips population was recorded after seven days of application in thiomethoxam 0.01 per cent (0.17) followed by imidacloprid 0.006 per cent (0.24), dimethoate 0.03 per cent (0.38) and acephate 0.075 per cent (0.44), which were at par in its efficacy. The treatment with achook 1500 ppm (0.71), neem oil 3000 ppm (0.80), NSKE 5 per cent (0.85) and fipronil 0.0025 per cent (0.92)

were less effective. The spray with *Verticillium lecani* 10^8 cfu/ml was least effective compare to rest of the treatments which showed a thrips population of 1.01 per spike.

Whitefly, *T. ricini*

The results on whitefly population recorded at different interval after insecticidal application are presented in Table 3 and Figure 5 and 6.

The mean whitefly population 24 hrs after first application of insecticides (Table 3 and Figure 5) revealed that all the treatments were significantly superior over control (0.99 whitefly/leaf). Imidacloprid 0.006 per cent recorded least number of whiteflies per leaf (0.27), which was at par with dimethoate 0.03 per cent (0.33), acephate 0.075 per cent (0.35) and thiomethoxam 0.01 per cent (0.56). The remaining treatments *viz.,* NSKE 5 per cent (0.67), neem oil 3000 ppm (0.67), fipronil 0.0025 per cent (0.69), achook 1500 ppm (0.71) and *Verticillium lecani* 10^8 cfu/ml (0.71) were less effective, however significantly superior over control in its efficacy. Whitefly population at 48 hrs after application of first spray of insecticides revealed that all the treatments were significantly superior over control (0.94 whitefly/leaf). Minimum whitefly population was recorded in the plot treated with imidacloprid 0.006 per cent (0.24) and it was at par with dimethoate 0.03 per cent (0.29), acephate 0.075 per cent (0.33) and thiomethoxam 0.01 per cent (0.48). The treatment with NSKE 5 per cent (0.60), fipronil 0.0025 per cent (0.62), achook 1500 ppm (0.62) and neem oil 3000 ppm (0.62) have also established the effectiveness against whiteflies after 48 hrs of application and however spray with *Verticillium lecani* 10^8 cfu/ml (0.67) was found least effective. Whitefly population after 72 hrs of application indicated that all the treatments remained significantly superior over control (0.92 whitefly/leaf). Minimum whitefly population was recorded in the plots treated with imidacloprid 0.006 per cent (0.16), followed by dimethoate 0.03 per cent (0.17), acephate 0.075 per cent (0.22) and thiomethoxam 0.01 per cent (0.35). All these treatment were at par and significantly superior to control. The treatment with NSKE 5 per cent (0.50), achook 1500 ppm (0.52) and neem oil 3000 ppm (0.52) were less effective in reducing whitefly population and the remaining treatment *viz.,* fipronil 0.0025 per cent (0.54) and *Verticillium lecani* 10^8 cfu/ml (0.54) was found least effective, however found significantly superior over control. Even after seven days of application, all the treatments were found significantly superior over control (0.96 whitefly/leaf) in reducing of recording lowest population. Among the treatments, imidacloprid 0.006 per cent seemed to be the most effective and recorded lowest whiteflies per leaf (0.24). However, it was at par with dimethoate 0.03 per cent (0.31), acephate 0.075 per cent (0.50) and thiomethoxam 0.01 per cent (0.56) in its efficacy against whiteflies. The botanicals *viz.,* NSKE 5 per cent (0.58), achook 1500 ppm (0.60) and neem oil 3000 ppm (0.67) found moderately effective and the remaining treatment *Verticillium lecani* 10^8 cfu/ml (0.69) and fipronil 0.0025 per cent (0.71) were least effective, however it was significantly superior over control.

The results presented in Table 3 and Figure 6 revealed that the whitefly population ranged from 0.42 to 0.94 per leaf before spraying second spray of insecticides and differences among various plots was non-significant. The mean whitefly population after 24 hrs of second application of insecticides revealed that all the treatments were significantly superior over control (1.01 whitefly/leaf).

Imidacloprid 0.006 per cent proved to be the most effective and reported 0.19 whiteflies per leaf. However, it was at par with dimethoate 0.03 per cent (0.35), acephate 0.075 per cent (0.36) and thiomethoxam 0.01 per cent (0.48) in its efficacy against whiteflies. The remaining treatment *viz.*, achook 1500 ppm (0.54), fipronil 0.0025 per cent (0.58), neem oil 3000 ppm (0.58), *Verticillium lecani* 10^8 cfu/ml (0.60) and NSKE 5 per cent (0.62) were less effective, but it was significantly superior over control. More or less the similar trend was noticed in whitefly population after 48 hrs of second spray also. A perusal of the data depicted in Table 3 and Figure 6 revealed that all the treatments were significantly superior over control (1.06 whitefly/leaf). Minimum whitefly population was recorded in the plot treated with imidacloprid 0.006 per cent (0.17) and it was at par with dimethoate 0.03 per cent (0.26), acephate 0.075 per cent (0.31) and thiomethoxam 0.01 per cent (0.40). The treatment with achook 1500 ppm (0.48), fipronil 0.0025 per cent (0.50), neem oil 3000 ppm (0.50) and NSKE 5 per cent (0.52) found less effective and treatment *Verticillium lecani* 10^8 cfu/ml was least effective (0.58). All the treatments remained significantly superior over control after 72 hrs of second spray. Minimum whitefly population was recorded in the plots treated with imidacloprid 0.006 per cent (0.09), which was at par with dimethoate 0.03 per cent (0.12), acephate 0.075 per cent (0.17) and thiomethoxam 0.01 per cent (0.33). The remaining insecticides *viz.*, achook 1500 ppm (0.33), neem oil 3000 ppm (0.35), fipronil 0.0025 per cent (0.36), NSKE 5 per cent (0.36) and *Verticillium lecani* 10^8 cfu/ml (0.36) were found less effective in its efficacy. Even after seven days of application, all the treatments were found significantly superior over control (1.04 whitefly/leaf) in reducing whitefly population (Table 3 and Figure 6). Among the treatments, imidacloprid 0.006 per cent was most effective indicating whitefly population of 0.11 per leaf. However, it was at par with dimethoate 0.03 per cent (0.16), acephate 0.075 per cent (0.29) and thiomethoxam 0.01 per cent (0.36) in its efficacy against whiteflies. The treatments of NSKE 5 per cent (0.40), achook 1500 ppm (0.42) and neem oil 3000 ppm (0.46) have found moderately effective and the remaining treatments *viz.*, fipronil 0.0025 per cent (0.52) and *Verticillium lecani* 10^8 cfu/ml (0.60) were least effective.

Castor yield (kg/ha)

Castor seed yield obtained in various insecticidal treatments are summarized in Figure 7. The castor seed yield in different treatments varied from 3009 to 4655 kg/ha. The highest seed yield (4655 kg/ha) was recorded in the treatment with imidachloprid 0.006 per cent, which was at par with dimethoate 0.03 per cent (4040 kg/ha), acephate 0.075 per cent (3944 kg/ha) and thiomethoxam 0.01 per cent (3941 kg/ha).

These findings are closely associated with many workers have recommended 0.03% dimethoate for effective and economic control of whitefly on castor hybrid-3 (Patel *et al*., 1973). The efficiency of imidacloprid 0.006 per cent and dimethoate 0.03 per cent were reported as effective chemicals against castor leafhopper, *E. flavescens* (Parmar, 2004). Acetamiprid 20 SP @ 100 g a.i./ha and thiomethoxam25 WG @ 125 g a.i./ha were the most effective in controlling thrips, *S. dorsalis* and increasing yield (Agale *et al.*, 2010).

CONCLUSION

Among the various insecticides tested, imidacloprid 0.006 per cent was the most effective insecticide against leafhopper and whitefly, while thiomethoxam 0.01 per cent was found most effective insecticide

against thrips. Imidacloprid 0.006 per cent registered the lowest population of leafhopper and whitefly and recorded the highest yield of castor.

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Table 1: Efficacy of different insecticides against castor leafhopper, *E. flavescens* under field condition

Sr. No.	Treatment	Concentration	Average Number of Leafhopper Per Leaf									
			After First Spray					After Second Spray				
			Before Spray	24 Hrs.	48 Hrs.	72 Hrs.	7 Days	Before Spray	24 Hrs.	48 Hrs.	72 Hrs.	7 Days
1	Fipronil 5 SC	0.0025 %	1.74* (2.53)**	1.34 (1.30)	1.29 (1.16)	1.24 (1.04)	1.34 (1.30)	1.38 (1.40)	1.14 (0.80)	1.08 (0.67)	1.00 (0.50)	1.11 (0.73)
2	Thiomethoxam 25 WG	0.01 %	1.64 (2.19)	1.23 (1.01)	1.16 (0.85)	1.04 (0.58)	1.18 (0.89)	1.37 (1.38)	1.13 (0.78)	1.08 (0.67)	0.96 (0.42)	1.06 (0.62)
3	Imidacloprid 17.8 SL	0.006 %	1.61 (2.09)	1.08 (0.67)	0.97 (0.44)	0.88 (0.27)	0.95 (0.40)	1.23 (1.01)	0.92 (0.35)	0.88 (0.27)	0.81 (0.16)	0.88 (0.27)
4	Dimethoate 30 EC	0.03 %	1.65 (2.22)	1.12 (0.75)	1.09 (0.69)	0.99 (0.48)	1.04 (0.58)	1.25 (1.09)	1.02 (0.54)	1.01 (0.52)	0.82 (0.17)	0.89 (0.29)
5	Acephate 75 SP	0.075 %	1.64 (2.19)	1.13 (0.78)	1.11 (0.73)	1.03 (0.56)	1.14 (0.80)	1.33 (1.27)	1.02 (0.54)	1.00 (0.50)	0.90 (0.31)	1.01 (0.52)
6	*Verticillium lecani*	10^8 cfu/ ml	1.60 (2.06)	1.33 (1.27)	1.32 (1.24)	1.28 (1.14)	1.36 (1.35)	1.43 (1.54)	1.19 (0.92)	1.16 (0.85)	1.11 (0.73)	1.21 (0.96)
7	NSKE	5 %	1.62 (2.12)	1.29 (1.16)	1.22 (0.99)	1.14 (0.80)	1.26 (1.06)	1.35 (1.32)	1.13 (0.78)	1.10 (0.71)	0.99 (0.48)	1.10 (0.71)
8	Achook	1500 ppm	1.59 (2.03)	1.30 (1.19)	1.22 (0.99)	1.14 (0.80)	1.25 (1.09)	1.37 (1.38)	1.16 (0.85)	1.11 (0.73)	1.00 (0.50)	1.11 (0.73)
9	Neem oil	3000 ppm	1.63 (2.16)	1.31 (1.22)	1.25 (1.06)	1.17 (0.87)	1.26 (1.09)	1.38 (1.40)	1.15 (0.82)	1.13 (0.78)	0.99 (0.48)	1.11 (0.73)
10	Control (water spray)	-	1.60 (2.06)	1.61 (2.09)	1.64 (2.19)	1.63 (2.16)	1.63 (2.16)	1.58 (2.00)	1.60 (2.06)	1.62 (2.12)	1.63 (2.16)	1.60 (2.06)
S.Em. ±			0.10	0.06	0.07	0.07	0.08	0.08	0.07	0.06	0.06	0.07
C.D. at 5 %			NS	0.19	0.21	0.21	0.24	NS	0.20	0.19	0.16	0.21
C.V. %			10.37	8.74	9.88	10.48	11.50	9.83	10.12	9.99	9.34	11.31

* $\sqrt{x + 0.5}$ ***transformation***

*** Figures in parenthesis are retransformed values***

Table 2: Efficacy of different insecticides against castor thrips, *S. dorsalis* under field condition

Sr. No.	Treatment	Concentration	Average Number of Thrips Per Spike									
			After First Spray					After Second Spray				
			Before Spray	24 Hrs.	48 Hrs.	72 Hrs.	7 Days	Before Spray	24 Hrs.	48 Hrs.	72 Hrs.	7 Days
1	Fipronil 5 SC	0.0025 %	1.59* (2.03)**	1.23 (1.01)	1.20 (0.94)	1.14 (0.80)	1.24 (1.04)	1.43 (1.54)	1.18 (0.89)	1.14 (0.80)	1.08 (0.67)	1.19 (0.92)
2	Thiomethoxam 25 WG	0.01 %	1.63 (2.16)	0.97 (0.44)	0.92 (0.35)	0.84 (0.21)	0.89 (0.29)	1.26 (1.09)	0.86 (0.24)	0.82 (0.17)	0.79 (0.12)	0.82 (0.17)
3	Imidacloprid 17.8 SL	0.006 %	1.68 (2.32)	1.09 (0.69)	1.07 (0.64)	1.00 (0.50)	1.05 (0.60)	1.31 (1.22)	0.90 (0.31)	0.85 (0.22)	0.82 (0.17)	0.86 (0.24)
4	Dimethoate 30 EC	0.03 %	1.66 (2.26)	1.15 (0.82)	1.10 (0.71)	1.02 (0.54)	1.10 (0.71)	1.34 (1.30)	0.98 (0.46)	0.94 (0.38)	0.90 (0.31)	0.94 (0.38)
5	Acephate 75 SP	0.075 %	1.66 (2.26)	1.06 (0.62)	1.04 (0.58)	0.98 (0.46)	1.07 (0.64)	1.27 (1.11)	0.94 (0.38)	0.90 (0.31)	0.86 (0.24)	0.97 (0.44)
6	*Verticillium lecani*	10^8 cfu/ ml	1.65 (2.22)	1.32 (1.24)	1.32 (1.24)	1.25 (1.06)	1.34 (1.30)	1.49 (1.72)	1.22 (0.99)	1.19 (0.92)	1.16 (0.85)	1.23 (1.01)
7	NSKE	5 %	1.63 (2.16)	1.24 (1.04)	1.22 (0.99)	1.17 (0.87)	1.27 (1.11)	1.47 (1.66)	1.15 (0.82)	1.12 (0.75)	1.07 (0.64)	1.16 (0.85)
8	Achook	1500 ppm	1.68 (2.32)	1.30 (1.19)	1.27 (1.11)	1.24 (1.04)	1.29 (1.16)	1.39 (1.43)	1.08 (0.67)	1.04 (0.58)	0.98 (0.46)	1.10 (0.71)
9	Neem oil	3000 ppm	1.62 (2.12)	1.31 (1.22)	1.28 (1.14)	1.21 (0.96)	1.31 (1.22)	1.36 (1.35)	1.11 (0.73)	1.10 (0.71)	1.05 (0.60)	1.14 (0.80)
10	Control(water spray)	-	1.60 (2.06)	1.63 (2.16)	1.61 (2.09)	1.59 (2.03)	1.62 (2.12)	1.57 (1.96)	1.60 (2.06)	1.61 (2.09)	1.60 (2.06)	1.60 (2.06)
S.Em. ±			0.09	0.07	0.06	0.07	0.08	0.08	0.06	0.06	0.06	0.07
C.D. at 5 %			NS	0.21	0.17	0.20	0.24	NS	0.19	0.18	0.17	0.20
C.V. %			9.80	9.74	8.32	10.24	11.25	9.40	9.87	9.87	9.55	10.44

* $\sqrt{x + 0.5}$ ***transformation***

****Figures in parenthesis are retransformed values***

Table 3: Efficacy of different insecticides against castor whitefly, *T. ricini* under field condition

Sr. No.	Treatment	Concentration	Average Number of Whiteflies Per Leaf									
			After First Spray					After Second Spray				
			Before Spray	24 Hrs.	48 Hrs.	72 Hrs.	7 Days	Before Spray	24 Hrs.	48 Hrs.	72 Hrs.	7 Days
1	Fipronil 5 SC	0.0025 %	1.17* (0.87)**	1.09 (0.69)	1.06 (0.62)	1.02 (0.54)	1.10 (0.71)	1.07 (0.64)	1.04 (0.58)	1.00 (0.50)	0.93 (0.36)	1.01 (0.52)
2	Thiomethoxam 25 WG	0.01 %	1.21 (0.96)	1.03 (0.56)	0.99 (0.48)	0.92 (0.35)	1.03 (0.56)	1.05 (0.60)	0.99 (0.48)	0.95 (0.40)	0.91 (0.33)	0.93 (0.36)
3	Imidacloprid 17.8 SL	0.006 %	1.20 (0.94)	0.88 (0.27)	0.86 (0.24)	0.81 (0.16)	0.86 (0.24)	0.96 (0.42)	0.83 (0.19)	0.82 (0.17)	0.77 (0.09)	0.78 (0.11)
4	Dimethoate 30 EC	0.03 %	1.25 (1.06)	0.91 (0.33)	0.89 (0.29)	0.82 (0.17)	0.90 (0.31)	1.04 (0.58)	0.92 (0.35)	0.87 (0.26)	0.79 (0.12)	0.81 (0.16)
5	Acephate 75 SP	0.075 %	1.27 (1.11)	0.92 (0.35)	0.91 (0.33)	0.85 (0.22)	1.00 (0.50)	1.08 (0.67)	0.93 (0.36)	0.90 (0.31)	0.82 (0.17)	0.89 (0.29)
6	*Verticillium lecani*	10^8 cfu /ml	1.19 (0.92)	1.10 (0.71)	1.08 (0.67)	1.02 (0.54)	1.09 (0.69)	1.14 (0.80)	1.05 (0.60)	1.04 (0.58)	0.93 (0.36)	1.05 (0.60)
7	NSKE	5 %	1.23 (1.01)	1.08 (0.67)	1.05 (0.60)	1.00 (0.50)	1.04 (0.58)	1.09 (0.69)	1.06 (0.62)	1.01 (0.52)	0.93 (0.36)	0.95 (0.40)
8	Achook	1500 ppm	1.19 (0.92)	1.10 (0.71)	1.06 (0.62)	1.01 (0.52)	1.05 (0.60)	1.05 (0.60)	1.02 (0.54)	0.99 (0.48)	0.91 (0.33)	0.96 (0.42)
9	Neem oil	3000 ppm	1.18 (0.89)	1.08 (0.67)	1.06 (0.62)	1.01 (0.52)	1.08 (0.67)	1.06 (0.62)	1.04 (0.58)	1.00 (0.50)	0.92 (0.35)	0.98 (0.46)
10	Control (water spray)	-	1.18 (0.89)	1.22 (0.99)	1.20 (0.94)	1.19 (0.92)	1.21 (0.96)	1.20 (0.94)	1.23 (1.01)	1.25 (1.06)	1.26 (1.09)	1.24 (1.04)
S.Em. ±			0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.05
C.D. at 5 %			NS	0.18	0.17	0.18	0.17	NS	0.18	0.16	0.14	0.16
C.V. %			10.53	10.33	9.93	10.62	9.37	9.15	10.40	9.52	8.72	9.90

* $\sqrt{x + 0.5}$ ***transformation***

*****Figures in parenthesis are retransformed values***

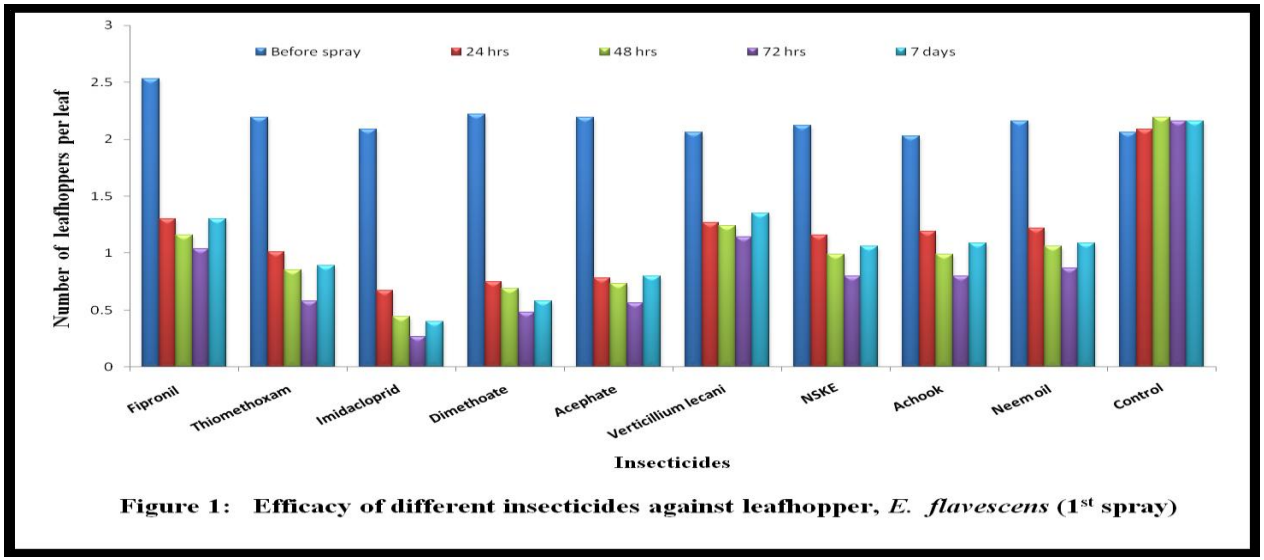

Figure 1: Efficacy of different insecticides against leafhopper, *E. flavescens* (1st spray)

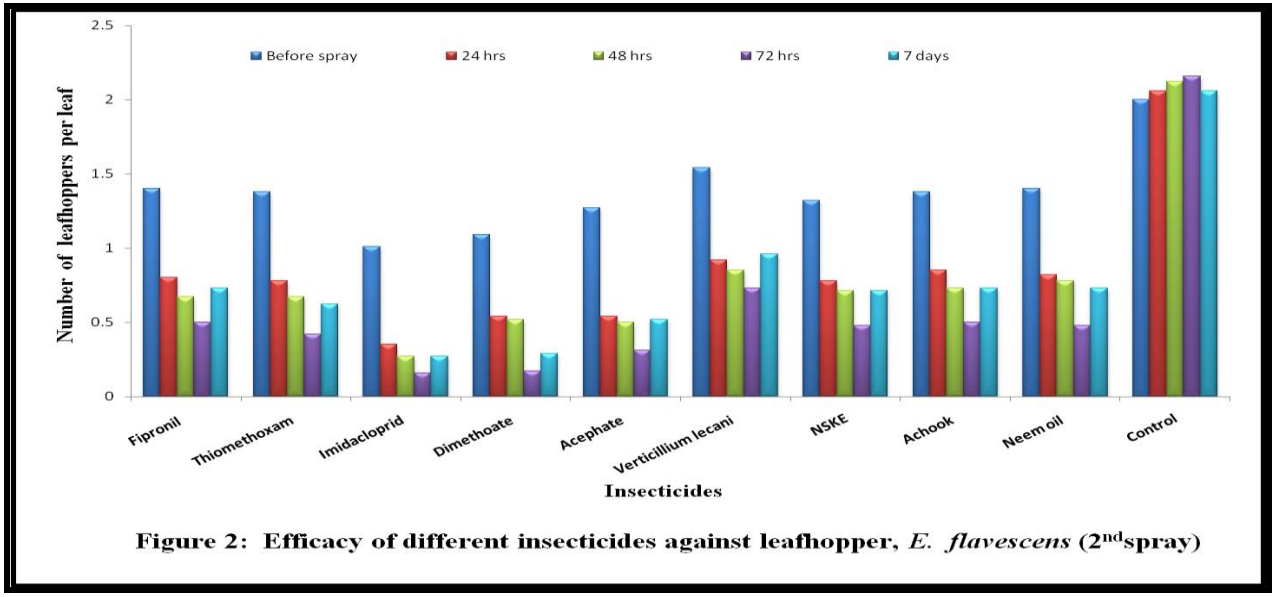

Figure 2: Efficacy of different insecticides against leafhopper, *E. flavescens* (2nd spray)

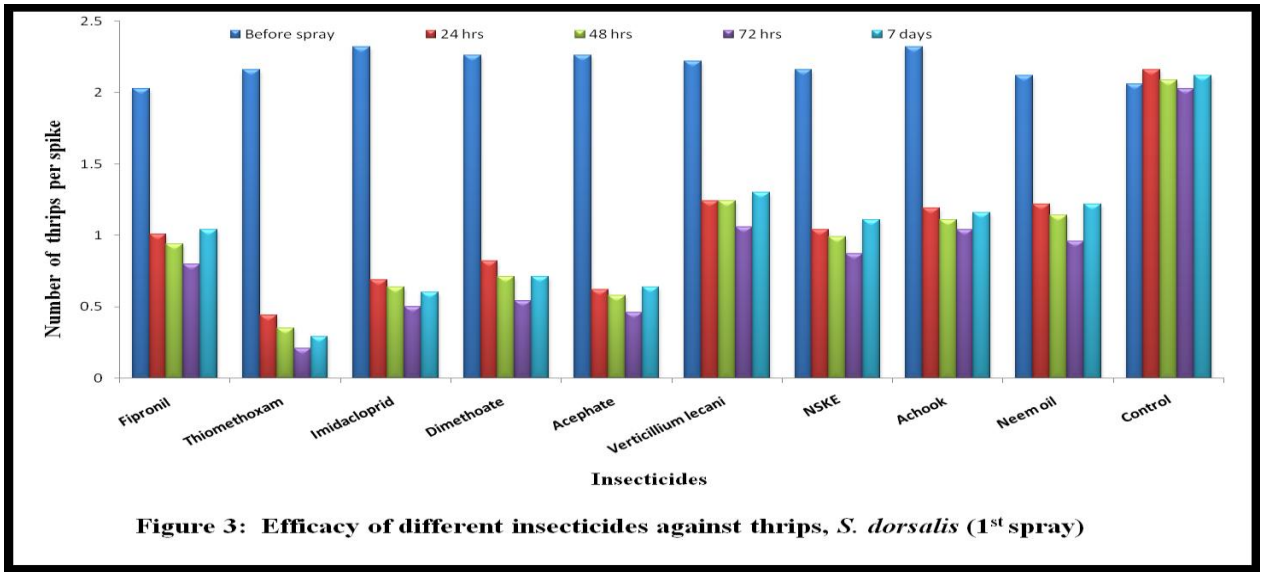

Figure 3: Efficacy of different insecticides against thrips, *S. dorsalis* (1st spray)

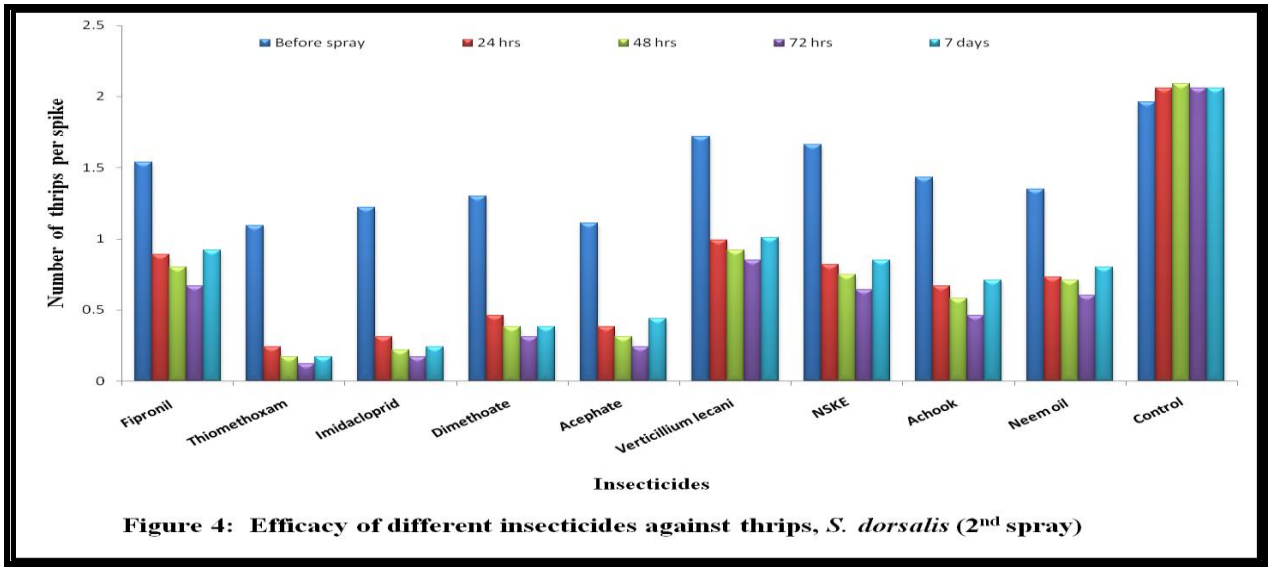

Figure 4: Efficacy of different insecticides against thrips, *S. dorsalis* (2nd spray)

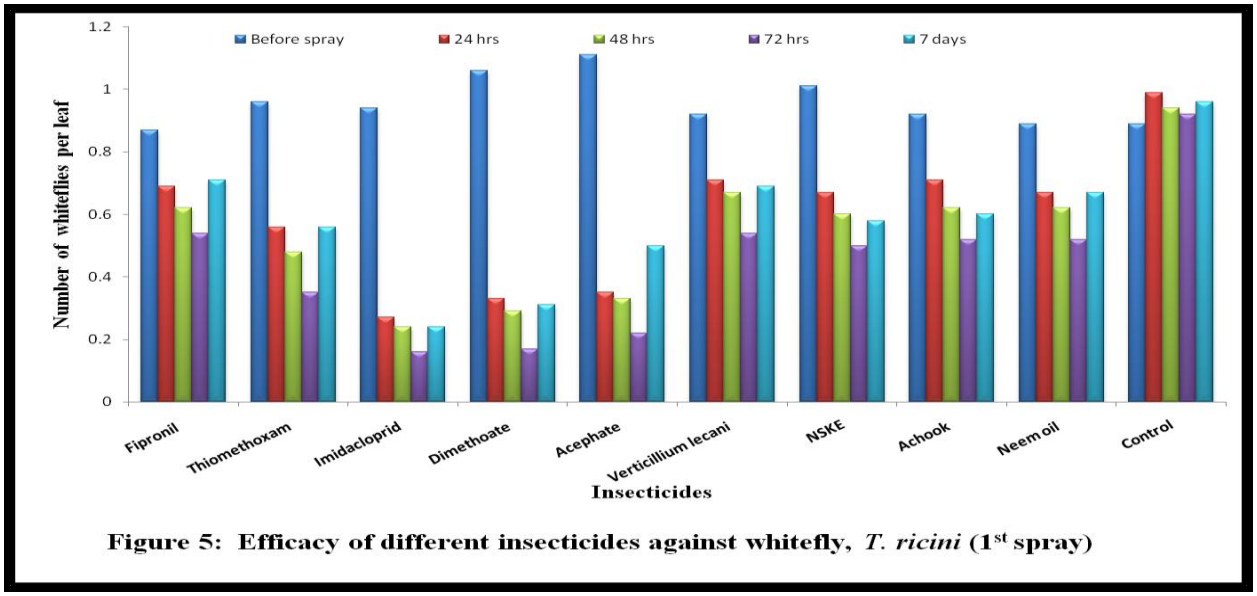

Figure 5: Efficacy of different insecticides against whitefly, *T. ricini* (1st spray)

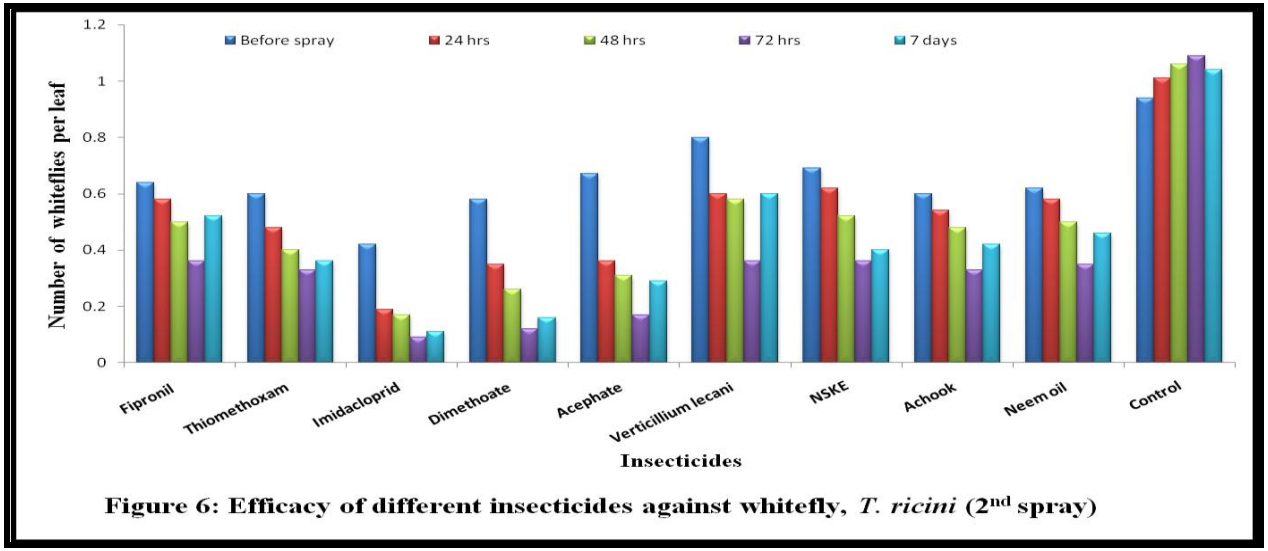

Figure 6: Efficacy of different insecticides against whitefly, *T. ricini* (2nd spray)

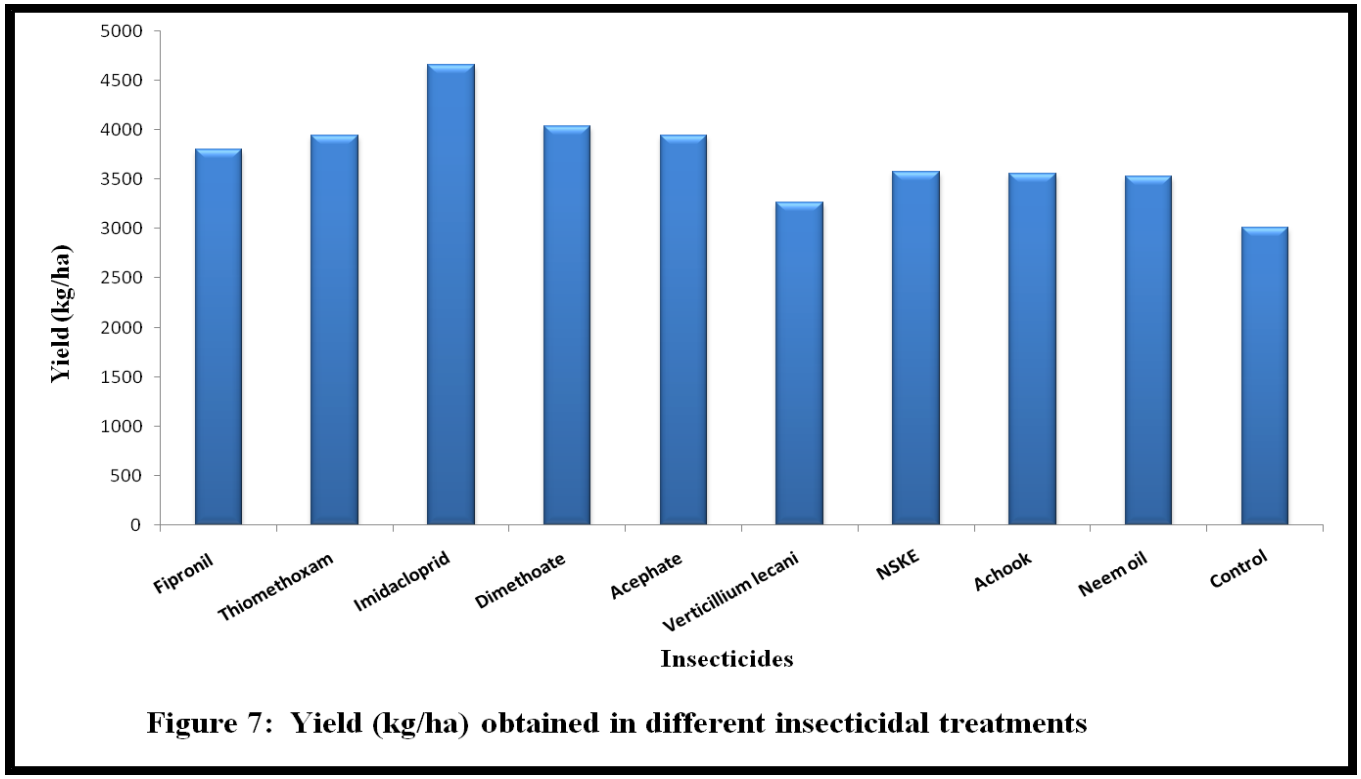

Figure 7: Yield (kg/ha) obtained in different insecticidal treatments

[MS received: January 30, 2014] *[MS accepted: February 26, 2014]*