Management of Chilli Leaf Curl Disease Complex in Jharkhand, India

N. Zeeshan¹, N. Kudada¹*, A. Saurav¹ and R. Prasad²

¹Department of Plant Pathology, ²Department of Entomology, Birsa Agricultural University, Ranchi, Jharkhand, India

*Corresponding author

Abstract

A field trial was conducted during Rabi, 2015-16 and Kharif, 2016 cropping seasons. An attempt was made to find out the cost effective management schedule to minimize the crop loss. Seven insecticides viz., Fipronil5% SC@800ml/ha, Indoxacarb 14.5% SC@400ml/ha, Acephate 75 SP@0.1%, Spinosad 45%SC@160ml/ha, Imidacloprid 17.8% SL@0.003%, Fenvalerate 20EC@500ml/ha and Carbofuran 3G@30Kg/ha were evaluated against vector activity to reduce the leaf curl disease incidence. The minimum disease incidence was recorded to the extent of (19.26 %) and (44.38 %) coupled with highest fruit yield of 87.78 q/ha and 65.94 q/ha in the treatment T7 having three times soil application of Carbofuran 3G @ 30 Kg/ha at an interval of ten days during both Rabi, 2015-16 and Kharif, 2016 cropping seasons, respectively. Maximum disease incidence was found in Kharif season. Minimum disease incidence was recorded during Rabi crop season in comparison to Kharif crop season. Infection by chili leaf curl disease complex adversely affected yield attributing characters during Kharif season as compared to Rabi season. Highest cost-benefit ratio of 1:13.80 and 1:11.60 was obtained by the application of Imidacloprid17.8 % @ 0.00 3 % during both Rabi and Kharif seasons, respectively.

Keywords
Chilli, Leaf curl, Management, Insecticides

Introduction

Chilli (Capsicum annuum L.) is considered as one of the most important vegetable and commercial spice crops grown throughout warm temperate, tropical and subtropical regions of the World. Chilli also called red pepper belongs to the genus Capsicum under the Solanaceae family. Besides traditional use of chilli as vegetables, spices, condiments, sauces and pickles it is also being used in pharmaceuticals, cosmetics and beverages (Tiwary et al., 2005). In Jharkhand, it is grown mostly in the districts of Ranchi, Hazaribag, Palamu and Giridih etc. Although there is a scope to enhance the productivity of chilli, a number of limiting factors have been attributed to the productivity. The damage caused by insect pests and mite is of paramount importance. Chilli is known as suffer from as many as eighty three different diseases (Anonymous, 1966). Among these fungi, bacteria and viruses diseases which are the major limiting factors in successful crop production, aphids (Myzuspersicae Sulzer), white fly (Bemisiatabaci Glover) and thrips (Scirtothrips dorsalis Hood) are the major insects which besides sucking the sap of the plant parts, also act as vectors of virus diseases like mosaic and leaf curl due to which
the crop suffers heavy losses (Singh et al., 1998). Venkatesh et al., (1998) reported that chilli leaf curl complex was caused by chilli leaf curl geminivirus (CLCV) transmitted by Bemisiatabaci also by thrips (Scirtothrips dorsalis) and mites (Polyphagotarsonemous latus). Senanayake et al., (2006) reported that a very high disease incidence (upto 100% plants during December 2004) in farmers’ fields in Narwa and Tinwari villages at Jodhpur district Rajasthan was observed. Chilli leaf curl disease complex causes huge crop losses in Jharkhand state primarily due to attack of thrips, mites and white fly followed by invasion of chilli leaf curl virus. Keeping in view the importance and losses, there is need of special emphasis to know the effect of insecticides and seasons on vector activity to spread chilli leaf curl disease complex.

Materials and Methods

To test the efficacy of seven insecticides on incidence of chilli leaf curl disease complex and fruit yield, a field trial was conducted in the glasshouse compound of the Department of Plant Pathology, Birsa Agricultural University, Ranchi, Jharkhand. The trial was conducted during Rabi, 2015-2016 and Kharif, 2016 cropping seasons using the variety, Mirch-444. The field trial was conducted in Randomize Block Design (RBD). There were eight treatments with three replications, including control. The plot size was 3m x 1.5 m with a spacing of 50 cm x 50 cm.

Recommended doses of fertilizers N: P: K and FYM were applied@100:60:50 kg/ha and 200q/ha, respectively. Nurseries were treated with Carbofuran 3G @ 5gm/m² including control. Thirty five days old seedlings were transplanted. Three sprays were given at an interval of ten days. Carbofuran 3G @ 2gm/plant was applied three times at an interval of 10 days. The details of treatments were as follows: T₁-Fipronil 5% SC @800 ml/ha, T₂-Indoxacarb 14.5 SC@ 400ml/ha, T₃-Acephate 75 SP @ 0.1 %, T₄-Spinosad 45%SC @ 160ml/ha, T₅-Imidacloprid 17.8%SL @ 0.003%, T₆-Fenvalerate 20 EC @ 500ml/ha, T₇-Soil application with Carbofuran3G @ 30Kg/ha, T₈-Control.

Results and Discussion

Chilli is grown during both Rabi and Kharif seasons in Jharkhand state. Like other crops chilli is also attacked by a number of diseases. Among these, chilli leaf curl disease complex is most prevalent. Seven insecticides namely Fipronil, Indoxacarb, Acephate, Spinosad, Imidacloprid, Fenvalerate and soil application of Carbofuran were evaluated for their effects on vector activities, disease incidence and yield attributing characters during Rabi, 2015-16 and Kharif, 2016 cropping seasons. Minimum disease incidence (19.26 percent) was observed intreatment T₇ (three times soil application of Carbofuran 3G) which was statistically superior to all other treatments. This treatment T₇ was followed by T₅ (Imidacloprid) (20.53 percent), T₄ (Spinogad) (20.91 percent) and T₃ (Acephate) (23.46 percent). Maximum green fruit yield (87.78 q/ha) was recorded in T₇ (three times soil application of Carbofuran 3G). This treatment (T₇) also recorded maximum increase in yield over control (45.01 percent) followed byT₅three sprays of Imidacloprid 17.5 % SL @ 0.003% (42.14 percent) and T₄ (38.42 percent).The maximum disease reduction over control was observed in T₇ (38.43 percent) followed by T₅ (34.15 percent) and T₄ (32.94 %) (Table 1 and Fig. 1). Highest cost-benefit ratio (1:13.80) was recorded by three sprayings with Imidacloprid 17.5% SL @ 0.003 percent (T₅) which was followed by T₄ (Spinogad 45% SC @ 160 ml/ha) (1:9.47), T₆ (Fenvalerate 20 EC @ 500 ml/ha) (1:7.43), T₃ (Acephate 75 SP@ 0.1 %)(1:6.16), T₁ (Fipronil 5% SC @ 800 ml/ha) (1: 3.22) and T₇(Carbofuran 3G @ 30 Kg/ha) (1:1.96).
Table 1: Effect of insecticides on leaf curl disease incidence and green fruit yield of chilli
Rabi, 2015-16 cropping season

| Treatments          | Dose       | Disease incidence (%) | Disease reduction over control (%) | Yield (q/ha) | Increase yield over control (%) |
|---------------------|------------|------------------------|------------------------------------|--------------|---------------------------------|
| T₁ - Fipronil 5% SC | 800 ml/ha  | 25.74(30.39)           | 17.45                              | 76.83        | 28.65                           |
| T₂ - Indoxacarb 14.5% SC | 400 ml/ha | 30.24(33.29)           | 3.25                               | 72.60        | 21.57                           |
| T₃ - Acephate 75 SP | 0.1%       | 23.46(28.95)           | 24.75                              | 82.29        | 37.79                           |
| T₄ - Spinosad 45% SC | 160 ml/ha | 20.91(27.20)           | 32.94                              | 82.67        | 38.42                           |
| T₅ - Imidacloprid 17.8% SL | 0.003% | 20.53(26.84)           | 34.15                              | 84.89        | 42.14                           |
| T₆ - Fenvalerate 20 EC | 500 ml/ha | 26.98(31.10)           | 13.48                              | 74.89        | 25.41                           |
| T₇ - Soil application of Carbofuran 3G | 30 Kg/ha | 19.26(25.95)           | 38.23                              | 87.78        | 45.01                           |
| T₈ - Control        | 31.18(34.32) | -                      | 59.72                              | -            | -                               |

S.Em ±: 1.535
C.D. at 5%: 0.238
C.V. %: 8.933

Table 2: Cost-Benefit ratio of insecticides
Rabi, 2015-16 cropping season

| Treatments          | Dose       | Yield (q/ha) | Additional yield over control (q/ha) | Value of additional yield @ Rs1000/q | Cost of insecticidal application (Rs) | Net Return/ha (Rs) | Cost - benefit ratio |
|---------------------|------------|--------------|-------------------------------------|--------------------------------------|--------------------------------------|-------------------|---------------------|
| T₁ - Fipronil 5% SC | 800 ml/ha  | 76.83        | 17.11                               | 17110                                | 4050                                 | 13060             | 1: 3.22             |
| T₂ - Indoxacarb 14.5% SC | 400 ml/ha | 72.60        | 12.88                               | 12880                                | 5910                                 | 6970              | 1: 1.17             |
| T₃ - Acephate 75 SP | 0.1%       | 82.29        | 22.57                               | 22570                                | 3150                                 | 19420             | 1: 6.16             |
| T₄ - Spinosad 45% SC | 160 ml/ha | 82.67        | 22.95                               | 22950                                | 2190                                 | 20760             | 1: 9.47             |
| T₅ - Imidacloprid 17.8% SL | 0.003% | 84.89        | 25.17                               | 25170                                | 1700                                 | 23470             | 1: 13.80            |
| T₆ - Fenvalerate 20 EC | 500 ml/ha | 74.89        | 15.17                               | 15170                                | 1800                                 | 13370             | 1: 7.43             |
| T₇ - Soil application of Carbofuran 3G | 30 Kg/ha | 87.78        | 28.06                               | 28060                                | 9450                                 | 18610             | 1: 1.96             |
| T₈ - Control        | 59.72      | -            | -                                   | -                                    | -                                    | -                 | -                   |

S.Em ±: 0.29
C.D. at 5%: 0.79
C.V. %: 11.76

Rate of insecticides: Kg⁻¹ or L⁻¹
Fipronil- Rs1125/-, Indoxacarb- Rs 3800/-, Acephate - Rs 750/-, Spinosad –Rs2416.67/-,
Imidacloprid-Rs 1167/-, Fenvalerate- Rs 300/-, Carbofuran- Rs 90/-Labour cost - Rs 225/-,
Rate of fruit-Rs 1000/-per quintal -, No. of applications -3.

2016
### Table 3 Effect of insecticides on yield attributing characters of chilli Rabi, 2015-16 cropping season

| Treatments          | Dose         | Mean Plant height (cm) | Mean no. of branches/plant (No.) | Mean no. of fruits/plant (No.) | Mean length/fruit (cm) | Mean breadth/fruit (cm) | Mean fruit weight/Plant (gm) |
|---------------------|--------------|------------------------|----------------------------------|--------------------------------|------------------------|------------------------|-----------------------------|
| T<sub>1</sub> - Fipronil 5% SC | 800ml/ha    | 50.67                  | 26.94                            | 31.37                          | 19.39                  | 2.67                  | 74.67                       |
| T<sub>2</sub> - Indoxacarb 14.5% SC | 400ml/ha   | 45.54                  | 22.87                            | 26.66                          | 18.79                  | 2.58                  | 71.12                       |
| T<sub>3</sub> - Acephate 75 SP | 0.1%        | 51.13                  | 28.00                            | 33.37                          | 19.94                  | 2.68                  | 75.00                       |
| T<sub>4</sub> - Spinosad 45%SC | 160ml/ha   | 54.26                  | 28.06                            | 35.82                          | 20.87                  | 2.71                  | 80.52                       |
| T<sub>5</sub> - Imidacloprid 17.8% SL | 0.003%   | 55.58                  | 28.89                            | 35.98                          | 20.94                  | 2.74                  | 82.20                       |
| T<sub>6</sub> - Fenvalerate 20 EC | 500ml/ha   | 46.00                  | 26.30                            | 27.40                          | 19.19                  | 2.65                  | 74.62                       |
| T<sub>7</sub> - Soil application of Carbofuran 3G | 30kg/ha    | 60.26                  | 31.24                            | 39.69                          | 23.26                  | 3.29                  | 104.64                      |
| T<sub>8</sub> - Control     | 44.25       | 22.35                  | 25.40                            | 17.52                          | 2.27                  | 66.04                 |                             |
| S.Em±               | 3.25         | 1.71                   | 3.05                             | 0.95                           | 0.14                   | 7.01                  |                             |
| C.D. at 5%          | 9.96         | 5.42                   | 9.34                             | 2.91                           | 0.43                   | NS                   |                             |
| C.V. %              | 11.05        | 11.04                  | 16.53                            | 8.22                           | 8.92                   | 15.42                 |                             |

**Figures in parentheses are arcsine transformed values.

### Table 4 Effect of insecticides on leaf curl disease incidence and green fruit yield of chilli Kharif, 2016 cropping season

| Treatments          | Dose            | Disease incidence (%) | Disease reduction over control (%) | Yield (q/ha) | Increase yield over control (%) |
|---------------------|-----------------|-----------------------|------------------------------------|--------------|---------------------------------|
| T<sub>1</sub> - Fipronil 5% SC | 800 ml/ha | 50.87 (46.43)**          | 18.55                                  | 53.72        | 30.65                          |
| T<sub>2</sub> - Indoxacarb 14.5% SC | 400ml/ha | 54.37 (47.52)             | 12.94                                | 44.38        | 7.93                           |
| T<sub>3</sub> - Acephate 75 SP | 0.1%           | 50.48 (45.49)            | 19.17                                | 55.40        | 34.73                          |
| T<sub>4</sub> - Spinosad 45%SC | 160ml/ha   | 50.58 (45.32)            | 19.01                                | 56.45        | 37.29                          |
| T<sub>5</sub> - Imidacloprid 17.8% SL | 0.003%   | 46.61 (43.02)            | 25.37                                | 58.89        | 43.22                          |
| T<sub>6</sub> - Fenvalerate 20 EC | 500ml/ha   | 53.78 (47.12)            | 13.89                                | 51.40        | 25.00                          |
| T<sub>7</sub> - Soil application of Carbofuran 3G | 30 Kg/ha   | 44.38 (41.70)            | 28.94                                | 65.94        | 60.36                          |
| T<sub>8</sub> - Control     | 62.45 (52.12)  | 41.12                  |                                     |              |                                 |
| S.Em±               | 1.73           | -                     | 0.22                                |              |                                 |
| C.D. at 5%          | 5.32           | 0.65                  |                                     |              |                                 |
| C.V. %              | 6.52           | 15.25                 |                                     |              |                                 |

**Figures in parentheses are arcsine transformed values.
**Table 5** Cost -Benefit ratio of insecticides

Kharif, 2016 cropping season

| Treatments         | Dose         | Yield (q/ha) | Additional yield over control (q/ha) | Value of additional yield @ Rs1000/q | Cost of insecticides application (Rs) | Net return (Rs) | cost – benefit ratio |
|-------------------|--------------|--------------|-------------------------------------|-------------------------------------|---------------------------------------|-----------------|----------------------|
| T1. Fipronil 5% SC | 800ml/ha     | 53.72        | 12.60                               | 12600                               | 4050                                  | 11730           | 1: 2.10              |
| T2. Indoxacarb 14.5% SC | 400ml/ha     | 44.38        | 3.26                                | 3260                                | 5910                                  | 6300            | 1: 0.30              |
| T3. Acephate 75 SP  | 0.10%        | 55.4         | 14.28                               | 14280                               | 3150                                  | 13360           | 1: 3.50              |
| T4. Spinosad 45% SC | 160ml/ha     | 56.45        | 15.33                               | 15330                               | 2190                                  | 14530           | 1: 6.00              |
| T5. Imidacloprid 17.8% SL | 0.003% | 58.89        | 17.77                               | 17770                               | 1700                                  | 15840           | 1: 11.60             |
| T6. Fenvalerate 20 EC | 500ml/ha     | 51.40        | 10.28                               | 10280                               | 1800                                  | 12800           | 1: 4.70              |
| T7. Soil application of Carbofuran 3G | 30 kg/ha | 65.94        | 24.28                               | 24280                               | 9450                                  | 10120           | 1: 1.60              |
| T8. Control        | -            | 41.12        | -                                   | -                                   | -                                     | -               | -                    |

S.E.m ±              | 1.74         | 0.31         | 0.35                                | 0.31                                | 0.03                                  | 1.93            |
C.D. at 5%            | 5.33         | 0.96         | 1.07                                | 0.95                                | 0.10                                  | 5.91            |
C.V. %                | 10.44        | 16.72        | 17.93                               | 14.71                               | 13.50                                 | 10.12           |

Rate of insecticides: Kg⁻¹ / L⁻¹
Fipronil - Rs1125/, Indoxacarb - Rs 3800/-, Acephate - Rs 750/-, Spinosad -Rs 2416.67/-, Imidacloprid- Rs 1167/-, Fenvalerate- Rs 300/-, Carbofuran- Rs 90/-, Labour cost- Rs 225/-, Rate of fruit- Rs 1000/-per quintal, No. of applications -3.

**Table 6** Effect of insecticides on yield attributing characters of chilli

Kharif, 2016 cropping season

| Treatments                   | Dose         | Mean Plant height (cm) | Mean no. of branches/plant (No.) | Mean no. of fruits/plant (No.) | Mean length/fruit (cm) | Mean breadth/fruit (cm) | Mean fruit Weight/plant (gm) |
|------------------------------|--------------|------------------------|---------------------------------|-------------------------------|-----------------------|------------------------|-----------------------------|
| T1. Fipronil 5% SC           | 800ml/ha     | 28.52                  | 2.90                            | 3.39                          | 3.54                  | 0.46                   | 30.48                       |
| T2. Indoxacarb 14.5% SC      | 400ml/ha     | 26.42                  | 2.70                            | 2.79                          | 3.14                  | 0.40                   | 30.48                       |
| T3. Acephate 75 SP           | 0.10%        | 29.05                  | 3.06                            | 3.45                          | 3.63                  | 0.52                   | 32.46                       |
| T4. Spinosad 45% SC          | 160ml/ha     | 30.58                  | 3.27                            | 3.74                          | 3.79                  | 0.54                   | 32.59                       |
| T5. Imidacloprid 17.8% SL    | 0.003%       | 31.76                  | 4.05                            | 4.01                          | 4.43                  | 0.56                   | 37.42                       |
| T6. Fenvalerate 20 EC        | 500ml/ha     | 27.65                  | 2.80                            | 3.25                          | 3.20                  | 0.43                   | 30.78                       |
| T7. Soil application of Carbofuran 3G | 30 kg/ha | 32.97                  | 4.50                            | 4.29                          | 4.65                  | 0.63                   | 39.95                       |
| T8. Control                  | -            | 24.03                  | 2.59                            | 2.29                          | 3.05                  | 0.36                   | 28.67                       |

S.E.m ±              | 1.74         | 0.31         | 0.35                                | 0.31                                | 0.03                                  | 1.93            |
C.D. at 5%            | 5.33         | 0.96         | 1.07                                | 0.95                                | 0.10                                  | 5.91            |
C.V. %                | 10.44        | 16.72        | 17.93                               | 14.71                               | 13.50                                 | 10.12           |
Fig. 1 Effect of insecticides on chilli leaf curl disease incidence and fruit yield
Rabi, 2015-16 cropping season
The treatment T₃ (Imidacloprid) also recorded highest net return/ha of Rs. 23,479/- followed by three foliar sprays of Spinosad (T₄) which recorded net return/ha of Rs. 20,760/-. Lowest cost-benefit ratio (1:1.17) was recorded in (T₂) (Indoxacarb 14.5 % SC@ 400 ml/ha) (Table 2).

Observations recorded on the effect of insecticides on yield attributing characters have been presented in Table 3. During Rabi, 2015-16 cropping season maximum mean plant height (60.26cm), mean no. of branches/plant (31.24), mean no. of fruits/plant (36.69), mean length/fruit (23.26cm), mean breadth/fruit (3.29cm), mean weight/plant (104.64gm) were recorded in T₇ (three times soil application of Carbofuran 3G @ 30 Kg/ha) which was statistically significant in comparison to
control. Mean weight/plant (104.64 gm) was also recorded maximum in treatment T\textsubscript{7} (three times soil application of Carbofuran 3G @ 30 Kg/ha) which was followed by T\textsubscript{5} (three sprays of Imidacloprid 17.8\% SL @ 0.003\%) (82.20 gm) and T\textsubscript{4} (three sprays with Spinosad 45\% SC @ 160ml/ha) 80.52 gm but it was statistically non-significant. All these characters were found to be statistically significant except mean weight/plant which was statistically non-significant.

During Kharif 2016 cropping season, all the treatments reduced the disease incidence significantly in comparison to control. Minimum disease incidence (44.38 percent) was recorded by the treatment T\textsubscript{7} (soil application of Carbofuran 3G @ 30 Kg/ha) coupled with highest fruit yield of 65.94 q/ha. The treatment T\textsubscript{7} was statistically at par with treatment T\textsubscript{5} (three sprays of Imidacloprid 17.8\% SL @ 0.003\%) which recorded disease incidence of 46.61 \% and fruit yield of 58.89 q/ha. Highest disease incidence (62.45 percent) and lowest yield of 41.12 q/ha was recorded in control. The treatment T\textsubscript{7} recorded maximum disease reduction overcontrol (28.94 percent) which was statistically superior to all other treatments followed by T5 (25.37 percent).

The increase in yield over control was highest in T7 (60.36 percent) followed by T5 (43.22 percent) (Table 4 and Fig. 2). Highest cost-benefit ratio of 1:11.60 was obtained when three sprays of Imidacloprid 17.8 \% @0.003\% was applied at an interval of ten days. This T\textsubscript{3} treatment also recorded net return/ha of Rs 15,840/- which was statistically superior to all other treatments followed by T4 (Spinosad 45 \% SC @ 160 ml/ha) (1:6.00) recorded cost - benefit ratio of 1:6.00 and net return of Rs. 14,530/- per ha. Lowest cost benefit ratio (1:0.30) was recorded by three sprays of Indoxacarb 14.5\% SC @ 400 ml/ha (T2) (Table 5). Maximum mean plant height (32.97 cm), mean number of branches per plant (4.50), mean number of fruits per plant (4.29), mean fruit length (4.65 cm), mean fruit breadth (0.63 cm) and mean fruit weight (39.95 g) were recorded by T7 (soil application of Carbofuran 3G @30 Kg/ha) followed by three sprays of Imidacloprid 17.8 \% SL @ 0.003 \% (T 5). These phenotypic characters were statistically significant (Table 6). Similar results were found by the earlier workers. Effectiveness of insecticidal sprays to lower disease development was on record (Nagaraju et al., 1997; Salam, 2005; Borah, 1995; Chakraborti, 2000). Application of insecticides significantly improved the dry chilli yield than untreated control (No spray). Ahmad and Prasad (2010) indicated that insecticide use can reduce thrips and borer populations on chilli plants by over 95\%, which leads to a doubling of yield in comparison to untreated plants. Rao et al., (1984) evaluated eighteen insecticides for the control of pest complex of chilli, acephate was recommended as the most effective compounds against the chilli pest complex as a whole.

Patnaik et al., (1985) found that fenvalerate resulted in the lowest damage index, with lowest incidence of S. dorsalis and highest fruit yield, followed by dimethoate. Hosmani (1993) mentioned that organic insecticides like, Fenvalerate (0.02\%) has been found effective in controlling Chilli thrips, when sprayed 4-6 rounds at 15 days interval, commencing from three weeks after transplanting. The curative action showed by Carbofuran could be due to its growth promoting properties (Venugopal and Litsinger, 1980). It is also possible that Carbofuran or its metabolites may have acted as antiviral compound that inhibit the multiplication of the virus within the host as caused by dodecyle benzene sulphonate on tobacco mosaic virus in Phaseolus vulgaris (Watanabe et al., 1982). The present
investigation revealed that three times soil application of Carbofuran 3G @ 30 Kg/ha was found to be best treatment for checking the vector activity of chili leaf curl disease complex resulting minimum disease incidence (19.26 and 44.38 percent) coupled with highest fruit yield of 87.78q/ha and 65.94 q/ha during Rabi 2015-16 and Kharif crop seasons, respectively than other treatments. This may be due to better protected nursery as well as the transplanted seedlings in the main field because of its systemic nature. The next affective treatment was Imidachloprid 17.8 % @ 0.003% which recorded disease incidence of 20.53 and 46.61 percent and fruit yield of 84.89 q/ha and 58.89 q/ha followed by Spinosad 45 % SC @ 160 ml/ha (20.91 and 50.58 percent), Acephate 75 SC @ 0.1% (23.46 and 50.48 percent) disease incidence. The more or less similar findings were also reported earlier by other workers. Imidacloprid was the best for managing leaf curl disease in chilli and the correct dosage and the concentration are 500 - 750 ml/l and 1.0 ml/l, respectively (Anon. 1995).The investigation revealed that Imidacloprid at 0.003% concentration level was found to be best treatment for checking the vector of leaf curl disease incidence and reduced maximum percent disease than the other treatments (Pandey et al., 2010). Vanisree et al., (2013) reported that the insecticides Spinosad 0.015% proved most effective against S. dorsalis followed by Diafenthiuron 0.045%, Pyrethroids 0.02% and Fipronil 0.01%.

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References

Ahmed, K. and Prasad, N.V.V.S.D. (2010). Evaluation of indoxacarb against fruit borers in chillies. Pesticide Research Journal, 22(2): 187-189.

Anonymous (1966). Index of Plant Virus Diseases. Agricultural Handbook No. 307, Agricultural Research Service, U.S. Department of Agriculture. P - 446.

Anonymous (1995). Techno guide for grain legumes, coarse grains and condiments. Department of Agriculture, Peradeniya, Sri Lanka.

Borah, R. K. (1995). Effect of synthetic pyrethroids and organo phosphorus insecticides on the Incidence of white fly [Bemisiatabaci Genn.] and yellow vein mosaic virus in green gram [Vigna radiate (L.) Wilczek]. Indian J. Virol. 11 (1): 75-76.

Chakraborti, S. (2000). Neem based integrated schedule for the control of vectors causing apical leaf curling in chilli. Pest Mngt. Econ.Zoolo.8 (1): 79-84.

Hosmani, M. H. (1993). Chilli crop (Capsicum annuum L.) Published by Mrs. Sarasjakashi M. Hosmani, Dharwad - 500008, pp. 178 –197.

Nagaraju, N., Reddy, H. R. and Ravi, K. S. (1997).Effect of exogenously applied plant products on pepper vein banding virus transmission, multiplication and symptom production in Bell pepper (Capsicum annuum L.). Indian J. Virol., 13 (2): 161-163.

Pandey, S. K., Matur, A. C. and Srivastava, M. (2010). Management of leaf curl disease of chilli (Capsicum annuum L.). International Journal of Virology.6: 246-250.

Patnaik, N.K., Behera, P.K., Dash, A.N. and Chode, M.K. (1985). Efficacy of insecticides against the chillithrips,
Scirtothrips dorsalis Hood (Thysanoptera: Thripidae). *Plant Prot. Bull.*, 37: 1-2.

Rao, D.M., Ahmed, K. and N.S. Murthy (1984). Chilli varieties and their reaction towards pests. *Indian Cocoa Areca nut Species J.*, 7: 118-119.

Senanayake, D.M.J.B., Mandal, B. Lodha, S., Varma, A. (2007). First report of Chilli leaf curl virus affecting chili in India. *J. Food Agric. Environ.*, 4:171-174.

Singh, U.C., Reeti, S. and Nagaich, K.N. (1998). Reaction of some promising chilli varieties against major insect pests and leaf curl disease. *Indian Journal of Entomology*, 60 (2): 181-183.

Vanisree, K., Upendhar, S., Rajasekhar, P., Ramachandra Rao, G. and SrinivasaRao, V. (2013). Field evaluation of certain newer insecticides against chillithrips, *Scirtothrips dorsalis* (Hood). *Science Park Research Journal*, 1(20): 1-13.

Venkatesh, H.M., Muniappa, V., Ravi, K.S. and Prasad, K. P.R. (1998). Management of chilli leaf curl complex. In: *Advances in IPM for horticultural crops*. (ed) Reddy, P.P., Kumar, N.K.K. and Varghese, A., In: *Proceedings of the First National Symposium on Pest Management in Horticulture Crops: Environmental Implications and Thursts*, Bangalore, India, 15-17, 111-117.

Venugopal, M.S. and Litsinger, J.A. (1980). Carbofuran – A direct growth stimulant of rice. In: 11th conference of the Pest Control Council, Philippines.

Watanable, T., Matsuzawa, Y., KO, K. and Mistao, T. (1982). Inhibitory action of dodecylbenzene sulphonate on TMV infection. *Rev. Plant Path. 61* (3): 89.

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