

Short Communication

Development and evaluation of integrated disease management module for leaf curl disease in chilli

Nagendran K, Shweta Kumari*, Vikas Dubey, Rajesh Kumar and KK Pandey

Received: March 2020 / Accepted: July 2020

Chilli (*Capsicum annum* L.), belonging to the family solanaceae, is being cultivated and consumed as vegetable and spice crop world-wide. Despite India ranks first in chilli production in the global scenario, chilli leaf curl disease (ChiLCD) associated with begomoviruses has emerged as a major constraint for its production. The symptoms associated with ChiLCD are curling of leaves, stunting of plants, reduced size of leaves, puckering and thickening of leaves, yellowing of veins and veinlets, etc. In severe cases, infected plants fail to produce fruits leading to 100% crop loss. Recent reports of ChiLCD in Indian subcontinent demonstrated the association of various begomoviruses such as chilli leaf curl virus (ChiLCV), chilli leaf curl India virus (ChiLCINV), chilli leaf curl Vellanad virus (ChiLCVV), tomato leaf curl Joydebpur virus, papaya leaf curl virus (PaLCuV), pepper leaf curl Bangladesh virus (PepLCBV) and tomato leaf curl New Delhi virus (ToLCNDV) (Kumar et al., 2015). In addition to their severe damage in inland conditions, ChiLCD are causing severe yield loss under island conditions too. Chilli leaf curl disease is the most destructive disease of chilli causing yield loss ranged from 25 to 80% (Pandurange Gouda 1979). Management of leaf curl disease in chilli crop becomes difficult due to wide host range of its associated begomoviruses, development of resistance by whiteflies to insecticides and lack of durable resistance in crop hosts. Control measures for its management may include an approach integrating different components of cultural, host plant resistance, chemical and biological measures. Several components such as plastic silver mulching, yellow sticky traps, border cropping, neem-based insecticides, etc. were identified from previous studies rendering effective

control over the insect population in vegetable crops (Kandan et al. 2002; Mandal et al. 2012; Thiribhuvanamala et al. 2013; Priyanka et al. 2018). In the present study, we developed and evaluated the management module for effective management of chilli leaf curl disease caused by begomovirus in an integrated manner under field conditions.

Field experiment was conducted in research farm of ICAR-IIVR at Varanasi in Uttar Pradesh during two consecutive years 2017-18 and 2018-19 to develop integrated disease management module against leaf curl disease of chilli with the following four treatments and five replications in randomized block design on susceptible chilli cultivar Pusa Jwala. Details of treatments are as follows: T1 - Seed disinfection using Virkon S @5g/l for 20 mins; Seed treatment with imidacloprid; Covering of nursery seedlings with insect proof net; Soil application with bioconsortia formulation@5g/l; Seedling dip with imidacloprid @ 0.5ml/lit followed by Carbendazim + Mancozeb@2.5g/l for 20 mins each; Soil application of FYM enriched with bioconsortia formulation (*Bacillus subtilis* BS-2); Soil application of neem cake@5g/plant; Raising of bajra as border crop; Installation of yellow sticky traps @20nos./acre; Periodical spraying with micronutrient mixture and Salicylic acid (2mM); Soil drenching with humic acid@5ml/l; Need based rotational application of insecticides such as neem oil, Cyantraniliprole, Chlorfenapyr and chlorantraniliprole at 10 days interval. T2- T1 + Black silver mulching; T3- Farmers practice comprising of periodical spray of imidacloprid 18.6%SL @0.5ml/l; and T4-Untreated control. Observations on plant height, yield and disease incidence were recorded in each replication and per cent disease reduction over control was also ascertained. The per cent disease incidence was calculated using the following formula:

Per cent Disease Incidence =

$$\frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

The plant height yield and disease incidence data obtained from the field experiments were analyzed using OPSTAT. The data in percentage were subjected to arcsine transformation before analysis (Sheoran *et al.* 1998).

There is no adequate single method is effective for controlling viral diseases to reduce yield losses (Makkouk and Kumari 2009). In the present study, we amalgamated different components to develop a module for the management of chilli leaf curl disease in an integrated manner. Different components such as seed disinfection using Virkon S followed by seed treatment with imidacloprid; raising seedlings nursery under insect proof net; Soil application with bio-formulation (BS-2) @5g/l; Seedling dip with imidacloprid followed by carbendazim + mancozeb before transplanting; installation of yellow sticky traps; black silver polythene mulching; growing bajra along the borders; soil application of FYM enriched bio-formulation (BS-2); soil application of neem cake; spraying of micronutrient mixture and salicylic acid to improve the immunity of plant; soil drenching with humic acid; and need based rotational application of insecticides for vector control. Pandey *et al.* (2010) observed that imidacloprid was most effective against chilli leaf curl disease than other insecticides used in chilli. Biocontrol agents were reported to induce resistance against viral diseases apart from enhancing growth and yield of the crop. Kandan *et al.* (2002) and Thiribhuvanamala *et al.* (2013) demonstrated the efficacy of *Pseudomonas fluorescens* (Pf1) treatment on tomato plants showed enhanced resistance against GBNV with higher yield. Similarly, soil application and foliar spray of *B. amyloliquefaciens* (VB7) has reduced *Tobacco streak virus* (TSV) incidence on cotton by 52% compared to untreated plots under field conditions. Also, same strain has reduced number of local lesions on indicator host upon artificial inoculation (Vinodkumar *et al.* 2018). Use of reflective silver or metalized coatings on polyethylene decreased

the number of thrips and tomato spotted wilt virus (TSWV) incidence in tomato (Stavisky *et al.* 2002; Hochmuth *et al.* 2008). Shirshikar (2008) reported reduction in the sunflower bud necrosis disease incidence, caused by TSV, upon protecting the main crop with border crop compared to the non-bordered one. Results of field experiment conducted at research farm of ICAR-IIVR for the management of chilli leaf curl disease revealed the highly variable nature of disease occurrence under natural field conditions. During 2017-18, there was no occurrence of chilli leaf curl disease. In 2018-19, maximum disease incidence of 27% has been recorded in untreated control plot and the least disease incidence was observed in IDM plot with mulching (10%) followed by IDM plot without mulching (13%). The incidence of leaf curl disease has reduced to 62.96% during 2018-19 in the IDM plot with mulching compared to untreated control. This is in corroboration with the findings of Priyanka *et al.*, (2018) stating that combined effect of yellow sticky trap, polythene mulching, border cropping and neem oil spray has reduced the thrip vectors population leading to lesser incidence of bud necrosis disease in IPM plots compared to the farmer's practice. Similarly, IPM strategy was significantly superior to farmer's practice and untreated control in reducing the per cent disease incidence of tomato leaf curl New Delhi virus and its whitefly vector population in ash gourd in addition to increase number of fruits per plant and fruits yield (Tamilnayagan *et al.* 2019). Low incidence of disease ultimately leads to increased crop yield. In the present investigation, due to the reduced incidence of chilli leaf curl disease in the IDM module with mulching, yield of green chilli (34.92q/ha) increased by 78.61% compared to untreated control (15.91q/ha). In the same way, fruit yield of watermelon in the IPM plot was increased by 16.7 - 50% over that of the farmer's practice developed for the management of bud necrosis disease (Priyanka *et al.* 2018). In addition to increase in yield, plant height is found to increase by 28.86% over the control plants. This might be due to plant growth promoting component such as micro nutrient, biocontrol agent and humic acid in the IDM module. The gross income (Rs. 419040/ ha) and cost

Table 1: Effect of different modules on chilli leaf curl disease incidence and yield

Module	Average disease incidence (%)	% reduction of disease over control	Average plant height (cm)	% increase of plant height over control	*Yield (q/acre)	% increase of yield over control	Gross income	CB ratio
IDM without mulching	13	51.85	37.55	18.05	27.80	36.08	1,01,180	1:1.4
IDM with mulching	10	62.96	40.99	28.86	34.92	78.61	1,46,620	1:1.5
Farmers practice	18	33.33	33.59	5.60	19.59	13.60	17,630	1:1.1
Untreated control	27	-	31.81	-	15.91	-	-(10,330)	1:0.95
CD	5.4		5.95		6.194			
C.V.	11.09		8.12		8.363			

*Mean yield of two seasons

benefit ratio (1:1.5) were recorded to be the highest in IDM module with mulching, followed by IDM module without mulching (Rs. 3,33600/ha and 1:1.4, respectively), whereas farmer's practices obtained cost benefit ratio of 1:1.1 (Table 1).

Since leaf curl disease of chilli is serious constraint to its crop cultivation, this study provides a feasible solution for its management using locally available IDM components. In future, devised module should be evaluated for its efficacy across the Indian subcontinent for effective management of leaf curl disease in chilli by resource poor farmers.

Acknowledgement

Authors are thankful to Science and Engineering Research Board (SERB), Department of Science and Technology, Government of India under Early Career Research Award (ECR/2016/000182) funding and Director (ICAR-IIVR) for providing facilities in conducting the research.

Reference

- Hochmuth GJ, Hochmuth RC and Olson SM (2008) Polyethylene mulching for early vegetable production in North Florida. University of Florida IFAS Extension. No. 805. <https://edis.ifas.ufl.edu/pdf/files/CV/CV21300.pdf>. Accessed 20 June 2017.
- Kandan A, Radjacomare R, Nandakumar R, Raguchander T, Ramiah M and Samiyappan R (2002) Induction of phenylpropanoid metabolism by *Pseudomonas fluorescens* against tomato spotted wilt virus in tomato. *Folia Microbiologica* 47(2): 121–129.
- Kumar RV, Singh AK, Singh AK, Yadav T, Basu S, Kushwaha N, Chattopadhyay B and Chakraborty S (2015) Complexity of begomovirus and betasatellite populations associated with chilli leaf curl disease in India. *Journal of General Virology* 96(10): 3143-3158.
- Makkouk KM and Kumari SG (2009) Epidemiology and integrated management of persistently transmitted aphids borne viruses of legume and cereal crops in West Asia and North Africa. *Virus Res* 141(2): 209–218.
- Pandey R, Chaturvedi AK, Chaudhary RP and Prasad R (2017) On-farm leaf curl disease management of chilli (*Capsicum annuum* L.). *Journal of Phytopathology and Pest Management* 4(2): 53-61.
- Pandurange Gowda, KT (1979) Studies on chilli (*Capsicum annuum* Linn.) mosaic viruses occurring in some parts of Kolar district. M. Sc. (Agri.) Thesis, Univ Agric Sci Bangalore, Karnataka (India).
- Priyanka R, Nagendran K, Aravintharaj R, Balaji CG, Mohankumar S, Renukadevi P and Karthikeyan G (2019) Characterization and management of watermelon bud necrosis virus infecting watermelon in India. *European Journal of Plant Pathology* 153(3): 759-770.
- Sheoran OP, Tonk DS, Kaushik LS, Hasija RC and Pannu RS (1998) Statistical Software Package for Agricultural Research Workers. Recent Advances in information theory, Statistics & Computer Applications by D.S. Hooda & R.C. Hasija Department of Mathematics Statistics, CCS HAU, Hisar.
- Shirshikar SP (2008) Integrated management of sunflower necrosis disease. *Helia* 31: 27–34.
- Stavisky J, Funderburk JE, Brodbeck BV, Olson SM, Andersen PC (2002) Population dynamics of *Frankliniella* spp. and tomato spotted wilt incidence as influenced by cultural management tactics in tomato. *Journal of Economic Entomology* 95: 1216–1221.
- Tamilnayagan T, Suganthi M, Ganapathy N, Renukadevi P, Malathi VG (2019) Integrated pest management strategies against *Bemisia tabaci* and Tomato leaf curl New Delhi virus (ToLCNDV) affecting ash gourd [*Benincasa hispida* (Thunb.) Cogn.] in Tamil Nadu. *J Expl Zool, India* 22(2): 1133-1138.
- Thiribhuvanamala G, Murugan M, Jayalakshmi V, Manoranjitham SK, Renuka Devi P, Rabindran R (2013) Strategic approaches for the management of peanut bud necrosis virus disease of tomato. *Pest Management in Horticultural Ecosystems* 19(1): 67–72.
- Vinodkumar S, Nakkeeran S, Renukadevi P, Mohankumar S (2018) Diversity and antiviral potential of rhizospheric and endophytic *Bacillus* species and phyto-antiviral principles against tobacco streak virus in cotton. *Agriculture, Ecosystems & Environment* 267: 42-51.