



ECOFRIENDLY MANAGEMENT OF LEAF CURL DISEASE OF CHILLI THROUGH BOTANICAL BIO-PESTICIDES

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Abstract

Chilli (*Capsicum annum* L.) is an important spice crop grown all over the world. The importance of chilli leaf curl, a viral disease has been recognized for many years, wherever chilli crop is grown. An experiment was designed to evaluate the efficacy of a few botanical pesticides against leaf curl viral disease in chilli. Minimum disease incidence (34.63-37.88%) was recorded in plots, which received seedlings treated with *Clerdendrum aculeatum* (leaf extract) followed by three foliar sprays of *Terminalia arjuna* (bark extract). Whereas, seedling treatment with *Clerdendrum aculeatum* (leaf extract) followed by three foliar sprays of *Terminalia arjuna* (bark extract) were observed maximum per cent disease control (60.72- 57.70%) along with fresh fruit yield (2.35-2.07 kg plot⁻¹) and an increase in fresh fruit yield (58.75-58.24%). Maximum plant height (55.83-55.19 cm), maximum plant canopy (72.31-67.55 cm), days of 50 per cent flowering (85.04-85.79DAT), maximum fruit weight (2.31-2.23g), maximum total number of fruit plant⁻¹ (72.29-70.63) and maximum number of seed fruit⁻¹ (58.35-57.70).

Key words : Ecofriendly, antiviral agents, leaf curl disease, chilli.

Introduction

Chilli (*Capsicum annum* L.) is an important spice crop cultivated in many countries throughout the world. India produces approximately 12.60 thousand metric tons from an area of 792.1 thousand hectares (Annon., 2012-13). Uttar Pradesh occupies an area of 13.47 thousand hectares with production of 10.30 metric tonnes (Annon., 2012-13). India is rich in diversity of chilli varieties with different nutritional quality. Besides traditional use of chilli such as vegetables, spices, condiments, sauces and pickles; it is being used in pharmaceuticals, cosmetics and beverages (Tiwari *et al.*, 2005). The average productivity of chilli is very low in India comparison to other countries because the crop is infested with many insects and diseases. It is because most of chilli varieties are susceptible to various pathogens; which cause heavy yield losses. Viruses are considered as one of the important limiting factor (Villalon, 1981). Among them, chilli leaf curl virus (Geminivirus) is most destructive viral pathogen in many parts of India, which is affecting chilli cultivation in terms of incidence and yield loss (Khan *et al.*, 2006). Thus, the farmers are protecting such a high value crop from diseases with the use of huge amount of pesticides, which results in resurgence of the pests, phytotoxicity on fruits,

human health hazards, destruction of beneficial microorganisms and environmental pollution. The recent emphasis is on the development of non-chemical / ecofriendly method for the management of this disease, which has provided impetus to more extensive exploration of natural resources and to identify effective plant extracts/botanical bio-pesticides for the managements of chilli leaf curl virus by reducing vector population in the field.

Materials and Methods

The experiment was conducted at Student's Instructional Farm, N. D. University of Agriculture and Technology, Kumarganj, Faizabad. Seeds were collected from the Department of Vegetable Science, N.D. University of Agriculture and Technology, Kumarganj, Faizabad. The experiment was conducted during two consecutive years (2014 and 2015) consisting of 13 treatment combinations *viz* T₁- root treatment with *Tinospora cordifolia* (aerial stem extract) @ 10%, T₂- root treatment with *Terminalia arjuna* (bark extract) @ 10%, T₃- root treatment with *Clerdendrum aculeatum* (leaf extract) @ 10%, T₄- Three foliar sprays of *Tinospora cordifolia* (aerial stem extract) @ 10%,

T₅- Three foliar sprays of *Terminalia arjuna* (bark extract) @ 10%, **T₆**- three foliar sprays of *Clerdendrum aculeatum* (leaf extract) @ 10%, **T₇**- Six foliar sprays of *Tinospora cordifolia* (aerial stem extract) @ 10%, **T₈**- Six foliar sprays of *Terminalia arjuna* (bark extract) @ 10%, **T₉**- Six foliar sprays of *Clerdendrum aculeatum* (leaf extract) @ 10%, **T₁₀**- **T₁ + T₇**, **T₁₁**- **T₂ + T₆**, **T₁₂**- **T₃ + T₅** and **T₁₃**- Control (untreated). The chilli cultivars LCA-235 are susceptible to leaf curl virus was laid out in Randomized Block Design with three replications. Field was ploughed once with disk harrow and thrice with cultivator followed by planking for making a good soil texture, fine tilt and smooth soil surface.

Recommended doses of nitrogen (100 kg ha⁻¹), phosphorus (50 kg ha⁻¹) and K₂O (50 kg ha⁻¹) were broadcast and mixed thoroughly in soil by light harrowing before sowing. The seedlings were raised in the nursery and seedlings were transplanted after 25 days in the experimental field having plot size 2.0×1.5 m with 60×45 cm spacing. The standard agronomical practices were followed to grow crop. The antiviral agents/botanical bio-pesticides were prepared by crushing different parts of plants, separately with distilled water (w/v) in a pestle and mortar. Crude extracts were prepared by making suspension in tap water (1:10). The pulp was strained through two folds of cheese cloth and the homogenate was subjected for centrifugation at 8000g for 15 minutes at 4°C. Stick material was added into supernatants for sticking on the leaves of host plants. (Madhusudan *et al.*, 2011). The first spray of plant extracts /botanical bio-pesticide (antiviral agents), @ 10% was done after first appearance of disease. The second, third and fourth sprays were done at eight days interval with same concentration. Roots of seedling were soaked in the aqueous suspension of botanical bio-pesticides separately *viz.* *Tinospora cordifolia* (aerial stem extract), *Terminalia arjuna* (bark extract) and *Clerdendrum aculeatum* (leaf extract) before transplanting. In control plots, water alone was sprayed instead of plant extracts. Observations were recorded at 15 days intervals starting from 14 days after transplanting (DAT) upto the last harvesting of fruits. First plucking of fruit was done at 45 DAT and second plucking was done at 60 DAT. The green fruit yield was recorded in terms of per plot. The growth data such as plant height (cm), plant canopy (cm), days of 50% flowering, fruit weight (g) per fruit, total number of fruit/plant and seed/fruit were recorded at the time of last harvest. The leaf curl disease incidence was recorded at 15, 30, 45 and 60 days after transplanting.

Per cent disease incidence and per cent disease control was calculated by the following formula :

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected plants per plots}}{\text{Number of plants (diseased + healthy) per plots}} \times 100$$

$$\text{Per cent disease control} = \frac{C - T}{C} \times 100$$

T = Per cent disease incidence in treated plot

C = Per cent disease incidence in untreated plot

Results and Discussion

Disease management

Data presented in tables 1 & 2 revealed significant effect of all the treatments on the management of chilli leaf curl virus. The disease symptoms could not be seen upto 15 days following transplanting in any treatment. After 30 days of transplanting, disease incidence recorded was lowest in seedling root treatment with *Clerdendrum aculeatum* + three foliar spray of *Terminalia arjuna* and highest in seedling root treatment with *Terminalia arjuna* (5.70%) in comparison to controls (7.03%). After 45 and 60 days of transplanting, the disease incidence was rapidly increased in all the treatments resulting 75.89 per cent and 94.05 per cent severity in control, respectively. The maximum disease control was observed in root treatment with *Clerdendrum aculeatum* + three foliar sprays of *Terminalia arjuna* 79.35%, 58.22% and 63.18% at 30, 45, and 60 DAT, Whereas, minimum disease control was recorded in seedling root treatment with *Terminalia arjuna* at 30 DAT (18.70%), 45 DAT (21.49%) and 60 DAT (13.53%) in 2014. Similar trends of treatments on disease managements were also recorded in the crop season 2015. The effects of plant extracts/ botanical bio-pesticides were highest at early growth stage, thus the increasing trends of plant infection were observed over the time. The findings were supported with Bediako *et al.* (2014) and Bhyan *et al.* (2007).

The foliar treatments were recorded highly effective for reducing the leaf curl disease in comparison to seedling root treatments in all the experimental years. The ability of foliar treatments was found increased when roots of seedling were treated with different plant extracts. The highest effect was observed in leaf extract of *Clerdendrum aculeatum* followed by aerial stem extract *Tinospora cordifolia* and bark extract of *Terminalia arjuna*. The *Clerdendrum aculeatum* leaf extract was found effective in reducing the leaf curl incidence and white fly population at early stage of crop upto 45 DAT. This is due to induce systemic resistance to delay the viral multiplication and symptoms expression

Table 1 : Effect of different plant parts extracts (bio-pesticides) on per cent disease incidence of chili leaf curl virus during 2014 and 2015.

S. no.	Treatments	Per cent disease incidence				Per cent disease control			
		15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
1.	T ₁ - Root treatment with <i>Tinospora cordifolia</i> (aerial stem extract) @ 10%	0.00	5.30(13.30)	62.98(52.52)	79.36(52.95)	0.00	24.30(29.37)	23.28(28.85)	15.62(23.28)
2.	T ₂ - Root treatment with <i>Terminalia arjuna</i> (bark extract) @ 10%	0.00	5.70(13.81)	64.45(53.41)	81.40(64.45)	0.00	18.70(25.44)	21.49(27.61)	13.53(21.57)
3.	T ₃ - Root treatment with <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	0.00	4.93(12.83)	62.30(52.13)	78.38(62.29)	0.00	29.66(32.96)	24.05(29.36)	16.65(24.05)
4.	T ₄ - Three foliar sprays of <i>Tinospora cordifolia</i> (aerial stem extract) @ 10%	0.00	3.80(11.24)	48.75(44.28)	56.53(48.75)	0.00	45.72(42.53)	39.16(38.75)	39.89(39.16)
5.	T ₅ - Three foliar sprays of <i>Terminalia arjuna</i> (bark extract) @ 10%	0.00	5.13(12.54)	50.19(45.12)	58.92(50.15)	0.00	26.73(31.04)	37.60(37.83)	37.19(37.58)
6.	T ₆ - Three foliar sprays of <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	0.00	3.73(11.13)	47.16(43.37)	53.77(47.25)	0.00	46.72(43.11)	40.87(39.75)	46.15(42.73)
7.	T ₇ - Six foliar sprays of <i>Tinospora cordifolia</i> (aerial stem extract) @ 10%	0.00	3.27(10.42)	41.28(39.98)	44.83(42.03)	0.00	53.29(46.97)	47.13(43.35)	52.31(46.32)
8.	T ₈ - Six foliar sprays of <i>Terminalia arjuna</i> (bark extract) @ 10%	0.00	3.33(10.52)	42.88(40.90)	45.16(42.21)	0.00	52.36(46.36)	45.44(42.38)	51.73(45.99)
9.	T ₉ - Six foliar sprays of <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	0.00	2.67(9.40)	38.27(38.21)	42.31(40.57)	0.00	62.90(52.49)	50.31(45.17)	56.27(48.61)
10.	T ₁₀ - T ₁ + T ₇	0.00	2.07(8.27)	32.71(34.89)	39.99(39.22)	0.00	70.59(57.17)	56.14(48.53)	57.37(49.24)
11.	T ₁₁ - T ₂ + T ₆	0.00	2.60(9.28)	37.07(37.51)	40.83(39.72)	0.00	63.82(53.04)	51.55(45.90)	56.58(48.78)
12.	T ₁₂ - T ₃ + T ₅	0.00	1.60(7.25)	30.62(33.60)	34.63(33.97)	0.00	79.35(62.98)	58.32(49.79)	63.18(52.64)
13.	T ₁₃ - Control (Untreated)	0.00	7.03(15.38)	75.89(60.60)	94.05(75.89)	0.00	0.00(0.284)	0.00(0.284)	0.00(0.284)
	SE_{ms}		(0.244)	(0.278)	(2.89)		(0.952)	(0.304)	(0.688)
	CD at (P=0.05)		(0.734)	(0.836)	(8.662)		(2.857)	(0.911)	(2.063)

*Figures in parenthesis are angular transformed value.

Table 2 : Effect of different plant parts extracts (bio-pesticides) on per cent disease incidence of chilli leaf curl virus during 2014 and 2015.

S. no.	Treatments	Per cent disease incidence				Per cent disease control			
		15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
1.	T ₁ - Root treatment with <i>Tinospora cordifolia</i> (aerial stem extract) @ 10%	0.00	6.27(14.50)	65.54(54.06)	83.19(65.79)	0.00	27.05(31.29)	17.19(24.50)	13.97(21.94)
2.	T ₂ - Root treatment with <i>Terminalia arjuna</i> (bark extract) @ 10%	0.00	6.80(15.11)	68.41(55.81)	84.05(66.46)	0.00	21.02(27.27)	12.89(21.04)	13.08(21.19)
3.	T ₃ - Root treatment with <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	0.00	5.20(13.18)	63.76(52.98)	81.68(64.66)	0.00	39.51(36.87)	18.81(25.70)	14.50(22.37)
4.	T ₄ - Three foliar sprays of <i>Tinospora cordifolia</i> (aerial stem extract) @ 10%	0.00	4.60(12.38)	54.85(47.79)	58.82(50.05)	0.00	46.47(42.97)	30.15(33.31)	39.17(38.74)
5.	T ₅ - Three foliar sprays of <i>Terminalia arjuna</i> (bark extract) @ 10%	0.00	6.20(14.41)	52.69(46.55)	62.94(52.42)	0.00	27.85(31.81)	32.90(34.99)	34.91(36.21)
6.	T ₆ - Three foliar sprays of <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	0.00	4.70(12.51)	50.75(45.42)	57.01(49.02)	0.00	46.09(44.57)	35.37(36.50)	41.04(39.83)
7.	T ₇ - Six foliar sprays of <i>Tinospora cordifolia</i> (aerial stem extract) @ 10%	0.00	4.20(11.83)	45.78(42.57)	48.48(44.12)	0.00	51.14(44.31)	41.70(40.22)	49.86(44.92)
8.	T ₈ - Six foliar sprays of <i>Terminalia arjuna</i> (bark extract) @ 10%	0.00	4.40(12.11)	44.93(42.09)	51.90(46.08)	0.00	48.80(44.31)	42.78(40.85)	46.33(42.89)
9.	T ₉ - Six foliar sprays of <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	0.00	3.57(10.89)	41.96(40.37)	44.68(41.94)	0.00	58.49(49.88)	46.56(43.02)	53.80(47.17)
10.	T ₁₀ - T ₁ + T ₇	0.00	3.23(10.36)	37.65(37.85)	41.70(40.22)	0.00	63.05(52.57)	52.06(46.18)	56.18(48.54)
11.	T ₁₁ - T ₂ + T ₆	0.00	3.70(11.09)	39.33(38.84)	42.67(40.78)	0.00	57.52(49.32)	49.92(44.95)	55.88(48.37)
12.	T ₁₂ - T ₃ + T ₅	0.00	1.90(7.92)	31.84(34.35)	37.88(37.98)	0.00	77.57(61.74)	59.46(50.45)	60.72(51.19)
13	T ₁₃ - Control (Untreated)	0.00	8.60(17.06)	78.53(62.39)	96.70(79.58)	0.00	0.00(0.284)	0.00(0.28)	0.00(0.284)
	SEM±		(0.137)	(0.172)	(0.294)		(1.07)	(0.197)	(0.319)
	CD at (P=0.05)		(0.411)	(0.516)	(0.882)		(3.23)	(0.590)	(0.956)

*Figures in parenthesis are angular transformed value.

Table 3 : Effect of different plant parts extracts (bio-pesticides) on growth parameters of chilli crop during 2014 and 2015.

S. no.	Treatments	Plant height (cm)		Plant canopy (cm)		Days of 50% flowering		Fruit weight (g)/fruit		Total no. of fruit/plant		No. of seed/fruit	
		2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
1.	T ₁ - Root treatment with <i>Tinospora cordifolia</i> (aerial stem extract) @ 10%	43.47	41.85	39.37	37.42	91.56	91.75	1.26	1.22	53.32	51.68	29.40	27.92
2.	T ₂ - Root treatment with <i>Terminalia arjuna</i> (bark extract) @ 10%	41.10	38.96	37.15	35.53	92.59	93.15	1.20	1.18	51.00	49.88	27.35	26.09
3.	T ₃ - Root treatment with <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	43.23	42.63	40.19	39.35	89.86	90.86	1.36	1.32	54.33	52.63	31.26	29.93
4.	T ₄ - Three foliar sprays of <i>Tinospora cordifolia</i> (aerial stem extract) @ 10%	48.13	48.18	55.42	53.43	88.91	89.81	1.64	1.67	57.82	56.59	38.41	37.26
5.	T ₅ - Three foliar sprays of <i>Terminalia arjuna</i> (bark extract) @ 10%	44.23	44.37	52.27	50.30	90.01	90.50	1.45	1.42	56.05	54.67	35.37	24.00
6.	T ₆ - Three foliar sprays of <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	49.7	49.71	58.32	56.35	89.68	90.12	1.60	1.57	59.90	58.89	40.07	39.71
7.	T ₇ - Six foliar sprays of <i>Tinospora cordifolia</i> (aerial stem extract) @ 10%	52.87	53.41	62.37	60.38	88.54	88.66	1.85	1.82	63.90	62.81	45.02	44.12
8.	T ₈ - Six foliar sprays of <i>Terminalia arjuna</i> (bark extract) @ 10%	51.03	49.81	60.23	59.64	89.18	89.68	1.75	1.72	61.87	60.36	42.32	40.67
9.	T ₉ - Six foliar sprays of <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	53.93	53.37	64.18	62.29	87.56	87.97	1.95	1.86	66.30	64.40	47.07	45.94
10.	T ₁₀ - T1 + T7	54.67	53.98	68.23	66.52	86.96	87.06	2.10	1.90	70.09	68.79	50.64	50.52
11.	T ₁₁ - T2 + T6	53.70	53.69	65.49	63.39	87.30	87.82	1.90	1.89	68.39	67.12	49.01	47.29
12.	T ₁₂ - T3 + T5	55.83	55.19	72.31	67.55	85.04	85.79	2.31	2.23	72.29	70.63	58.35	57.73
13.	T ₁₃ - Control (Untreated)	38.30	37.67	33.67	30.24	94.83	95.07	1.15	1.12	40.35	39.05	24.64	22.91
	SEm±	0.41	0.40	0.48	0.31	0.30	0.31	0.01	0.03	0.20	0.27	0.33	2.71
	CD at (P=0.05)	1.19	1.16	0.40	0.92	0.88	0.91	0.03	0.07	0.57	0.78	0.95	7.91

Table 4 : Effect of different plant parts extracts on fresh fruit yield (kg plot⁻¹) of chilli during 2014 and 2015.

S. no.	Treatments	2014					2015				
		Fresh yield (kg/plot)		Total fresh fruit yield/ plant (kg)	Per cent increase fresh fruit yield/ plant(kg/plot)	Fresh yield (kg/plot)		Total fresh fruit yield/ plant (kg/plot)	Per cent increase fresh fruit yield (kg/plot)		
		45 DAT	60 DAT			45 DAT	60 DAT				
1.	T ₁ - Root treatment with <i>Timospora cordifolia</i> (aerial stem extract)@ 10%	0.61	0.74	1.35	28.66	0.52	0.61	1.14	23.64		
2.	T ₂ - Root treatment with <i>Terminalia arjuna</i> (bark extract)@ 10%	0.61	0.74	1.35	28.18	0.52	0.61	1.13	23.20		
3.	T ₃ - Root treatment with <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	0.63	0.77	1.41	31.30	0.54	0.63	1.18	26.21		
4.	T ₄ - Three foliar sprays of <i>Timospora cordifolia</i> (aerial stem extract)@ 10%	0.73	0.89	1.63	40.63	0.64	0.75	1.38	37.39		
5.	T ₅ - Three foliar sprays of <i>Terminalia arjuna</i> (bark extract) @ 10%	0.71	0.87	1.57	38.58	0.61	0.72	1.33	34.66		
6.	T ₆ - Three foliar sprays of <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	0.79	0.96	1.75	44.50	0.68	0.80	1.48	41.48		
7.	T ₇ - Six foliar sprays of <i>Timospora cordifolia</i> (aerial stem extract)@ 10%	0.85	1.03	1.88	48.59	0.75	0.88	1.62	46.58		
8.	T ₈ - Six foliar sprays of <i>Terminalia arjuna</i> (bark extract) @ 10%	0.86	1.05	1.91	49.35	0.75	0.88	1.63	47.03		
9.	T ₉ - Six foliar sprays of <i>Clerodendrum aculeatum</i> (leaf extract) @ 10%	0.94	1.15	2.09	53.69	0.84	0.99	1.83	52.70		
10.	T ₁₀ - T ₁ + T ₇	1.00	1.22	2.21	56.25	0.88	1.04	1.92	55.01		
11.	T ₁₁ - T ₂ + T ₆	1.01	1.23	2.24	56.77	0.91	1.06	1.97	56.17		
12.	T ₁₂ - T ₃ + T ₅	1.06	1.29	2.35	58.75	0.95	1.12	2.07	58.24		
13.	T ₁₃ - Control (Untreated)	0.43	0.53	0.97	0.00	0.40	0.47	0.86	23.64		
	SEm±	-	-	0.06	1.60	-	-	0.04	1.66		
	CD at (P=0.05)	-	-	0.17	4.66	-	-	0.12	4.85		

reported by Verma and Mukerjee (1975).

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