Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(1): 1045-1049
Received: 04-11-2018
Accepted: 06-12-2018

Zeeshan N
Department of Plant Pathology, Faculty of Agriculture, Birsa Agricultural University, Ranchi, Jharkhand, India

Kudada N
Department of Plant Pathology, Faculty of Agriculture, Birsa Agricultural University, Ranchi, Jharkhand, India

Correspondence
Kudada N
Department of Plant Pathology, Faculty of Agriculture, Birsa Agricultural University, Ranchi, Jharkhand, India

Ecofriendly management of chilli leaf curl disease complex through plant products

Zeeshan N and Kudada N

Abstract
A field trial was conducted during Rabi, 2015-16 cropping seasons. An attempt was made to find out the cost effective management schedule to minimize the crop loss. Seven plant products viz., Neem (*Azadirachta indica* L.) oil 0.03% 5ml/lit. Neem (*Azadirachta indica* L.) Seed Kernel Extract (NSKE) 5 % @ 5ml/lit. Karanj (*Pongamia pinnata* L.) oil @ 5ml/ lit. Nimbicidine 0.03% @ 3ml/lit., Achook 0.03% @ 3ml/lit., Neem gold 0.15 % @ 2ml/lit. and Nimactin 0.15% @ 2ml/lit. were evaluated against vector activity to reduce the leaf curl disease incidence. The minimum disease incidence was recorded to the extent of (23.45%) coupled with highest fruit yield of 64.45 q/ha in the treatment T2 having two sprayings of NSKE 5% @ 5ml /lit. at an interval of ten days during Rabi, 2015-16 cropping season. Maximum disease incidence (35.45%) in control with lowest yield (48.00/ha). Infection by chili leaf curl disease complex adversely affected yield attributing characters during Rabi season. Highest cost-benefit ratio of 1:17.13 was obtained by two sprayings of NSKE 5% @ 5ml/lit. During Rabi crop season.

Keywords: Chilli, leaf curl, management, plant products

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) [27]. 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 (*Myzus persicae* Sulzer), white fly (*Bemisia tabaci* 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 *Bemisia tabaci* also by thrips (*Scirtothrips dorsalis*) and mites (*Polyphagotarsonemus latus*). Senanayake *et al.* (2006) [21] 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. The objective of this study was to evaluate different plant products on vector activities to reduce chilli leaf curl disease complex.

Materials and Methods
To test the efficacy of seven plant products on incidence of chilli leaf curl disease complex, fruit yield and yield attributing characters, a field trial was conducted in glasshouse compound of Department of Plant Pathology, Birsa Agricultural University, Kanke, Ranchi, Jharkhand. The field trial was conducted in Randomized Block Design (RBD) during Rabi, 2015-16 crop season using the variety G-4. There were eight treatments with three replications. The plot size was 3 m x 1.5 m. Sterilized distilled water was sprayed with each spray in control plots. Required concentrations of all the seven plant products were sprayed two times in each plot. First foliar spaying was applied at 35 days after transplanting and second spraying was applied at 10 days after first spraying. Recommended doses of fertilizers N:P:K and FYM were applied @ 100:60:50/ha and 200 q/ha, respectively. Thirty five days old seedlings

trans planted. The details of treatments were as follows: T_1 - Neem (*Azadirachta indica* L.) oil 0.03% @ 5ml/lit, T_2 - NSKE 5% @5ml/lit, T_3 – Karanj (*Pongamia pinnata* L.) oil @ 5ml/lit, T_4 - Nimbicidine 0.03% @ 3ml/lit, T_5 - Achook 0.03% @ 3ml/lit, T_6 - Neem (*Azadirachta indica* L.) gold 0.15% @ 2ml/lit, T_7 - Nimactin 0.15% @ 2ml/lit, T_8 - Control. Disease incidence was observed in each plot by counting total number of plants as well as diseased plants.

Percent disease incidence was calculated by following formula suggested by Nene (1972):

$$\% \text{ Disease Incidence} = \frac{\text{No. of Diseased units}}{\text{Total no. of assessed units}} \text{x100}$$

Percent disease reduction was calculated by following formula:

$$\text{Percent disease reduction} = \frac{\text{C-T}}{\text{C}} \text{x100}$$

Where,
C - Percent disease incidence in untreated plants,
T - Percent disease incidence in treated plants.

The per cent increase of yield in treatment over control was calculated from the following formula (Vanisree *et al.*, 2013).

$$\text{Per cent increase of yield in treatment over control} = \frac{\text{Yield in treatment - Yield in control}}{\text{Yield in control}} \text{x100}$$

The fruit yield was recorded during the entire crop season and converted to per hectare. Yield was estimated after final picking of fruits. Cost - benefit ratio was calculated by using formula as follows:

$$\text{Cost - benefit ratio} = \frac{\text{Net profit (Rs.)}}{\text{Cost of application}}$$

Net Profit = Value of additional yield over control (Rs.) – Cost of application (Rs)

Following yield attributing characters were recorded as follows:
Plant height (cm), 2. No. of branches/plant (no.), 3. Fruit length (cm), 4. Fruit breadth (cm), 5. Fruit weight (gm). Yield attributing characters were recorded from randomly selected five plants in each replication of each treatment at maturity stage of crop.

Results and Discussion

Chilli is grown during both Ra bi and Kharif seasons in Jharkhand state. The crop is attacked by a number of diseases. Among these, chilli leaf curl disease complex is most prevalent. Seven plant products viz. Neem oil, Neem Seed Kernel Extract (NSKE), Achook, Neem gold, Nimactin, Nimbicidine, Karanj oil evaluated for their effects on vector activities, disease incidence and yield attributing characters during Rabi, 2015-16 cropping season. Neem products are well established commercially as botanical pesticides (Gurjar *et al.*, 2012) [8].

The data (Table-1) revealed that all the plant products reduced the disease incidence significantly in comparison to control. Two sprayings of NSKE 5% (T2) was recorded to the most effective botanical in reducing disease incidence (23.45%) coupled with highest yield (64.45 q/ha). The treatment T2 (NSKE 5%) was followed by Neem oil 0.03% (T1) having disease incidence of 24.63% and yield of 33.82 q/ha. Maximum disease incidence (35.45 percent) and lowest yield of 48.00q/ha was observed in control. The treatments T2 (NSKE 5%), T1 (Neem oil 0.03%) and T4 (Nimbicidine 0.03%) were significantly at par with each other. The maximum disease reduction over control was observed in T2 (33.86 %) followed by T1 (30.52 percent) and T4 (30.19 percent).The increase in yield over control was highest in T2 (34.28%) followed by T1 (33.82 %). Considering the per rupee returns, application of neem seed Kernel extract (NSKE) 5% @5 ml/lit. was highly economical which recorded cost-benefit ratio of 1:17:13 and net return/ha of Rs. 15543/- followed by application of neem gold 0.15% and neem oil 0.03% recorded cost-benefit ratio of 1:9.03 and 1:8.29, respectively. But, higher net return of Rs. 14484/- per ha was recorded by neem oil than neem gold which recorded net return of Rs. 9210/- per ha. Lowest cost-benefit ratio (1:1.23) was recorded in the plot treated with Karanj oil @ 5ml/lit (T2) (Table 2).

Observation on the effect of plant products on yield attributing characters have been presented in Table-3. During Rabi, 2015-16 cropping season maximum mean plant height (38.69 cm), mean no. of branches per plant (5.30), mean length per fruit (6.10 cm), mean breadth per fruit (0.80 cm) and mean fruit weight per plant (44.75 gm) were recorded in treatment T2 (two foliar sprays of NSKE 5%) followed by T1 (two foliar sprays of Neem oil 0.03%) and T4 (two foliar sprays of Nimbicidine 0.03%). All the treatments were found to be statistically superior over control.

Table1: Effect of plants products on Chilli leaf curl virus disease incidence and green fruit yield Rabi, 2015-16 cropping season

Treatments	Dose (ml/lit)	Leaf curl disease incidence (%)	Disease reduction over control (%)	Yield (q/ha)	Increase yield over control (%)
T_1 – Neem oil 0.03%	3	24.63(31.90)**	30.53	64.23	33.82
T_2 – NSKE 5%	5	23.45(30.05)	33.86	64.45	34.28
T_3 – Karanj oil 0.15%	5	32.90(35.99)	7.20	50.67	5.56
T_4 - Nimbicidine 0.03%	5	24.75(29.80)	30.19	63.34	31.96
T_5 - Achook 0.03%	3	26.89(30.73)	24.15	61.12	27.34
T_6 - Neem gold 0.15%	2	26.96(31.20)	23.95	58.23	21.31
T_7 - Nimactin 0.15%	2	30.24(33.30)	14.70	53.12	10.67
T_8 - Control	-	35.45(37.10)	-	48.00	-
S.Em ±		1.54		0.172	
C.D. at 5%		4.70		0.53	
C.V. %		8.86		11.41	

**Figures in parentheses are arcsine transformed values

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

Treatments	Dose (ml/lit)	Yield (q/ha)	Additional yield over control (q/ha)	Value of additionl Yield @ Rs. 1000/q	Cost of insecticidal Application (Rs.)	Net Return/ha (Rs.)	Cost benefit Ratio (Rs.)
T_1 - Neem oil 0.03%	3	64.23	16.23	16230	1746	14484	1:8.29
T_2 - NSKE 5%	5	64.45	16.45	16450	907	15543	1:17.13
T_3 - Karanj oil 0.15%	5	50.67	2.67	2670	1200	1470	1:1.23
T_4 - Nimbicidine 0.03%	5	63.34	15.34	15340	3000	12340	1:4.12
T_5 - Achook 0.03%	3	61.12	13.12	13120	1440	11680	1:8.12
T_6 - Neem gold 0.15%	2	58.23	10.23	10230	1020	9210	1:9.03
T_7 - Nimactin 0.15%	2	53.12	5.12	5120	1010	4110	1 4.07
T_8 - Control		48.00	-	-			-
S.Em ±		0.17					
C.D. at 5%		0.53					
C.V. %		11.41					

Rate of application: L-[1]

Neem oil –RS 700/-, NSKE 5% - Rs 410/-, Karanj oil- Rs 500/-, Achook- Rs 300/-, Neem gold- Rs 500/-,Nimactin –Rs 460/-, Nimbicidine – Rs 470/- Labour cost - Rs 225/- Rate of fruit - Rs 1000/per quintal, No. of sprayings -2

Table 3: Effect of plant product on yield attributing characters of chilli Rabi, 2015-16 cropping season

Treatments	Dose (ml/lit)	Mean plant height (cm)	Mean no. of branches/plant (No.)	Mean length/ fruit (cm)	Mean breadth/ fruit (cm)	Mean fruit Weight/plant (gm)
T_1 – Neem oil 0.03%	3	36.89	5.10	5.70	0.78	44.18
T_2 – NSKE 5%	5	38.69	5.30	6.10	0.80	44.75
T_3 – Karanj oil 0.15%	5	32.58	3.66	4.50	0.62	37.25
T_4 – Nimbicidine 0.03%	5	36.66	5.00	5.40	0.77	43.75
T_5 – Achook 0.03%	3	36.43	4.55	5.25	0.75	42.75
T_6- Neem gold 0.15%	2	35.53	4.24	5.10	0.67	41.33
T_7 – Nimactin 0.15%	2	33.92	4.12	4.50	0.63	38.50
T_8 - Control		30.02	3.38	4.00	0.50	33.20
S.Em ±		1.66	0.36	0.38	0.06	2.36
C.D. at 5%		5.09	1.12	1.17	0.18	7.23
C.V. %		8.19	14.23	12.91	14.85	10.04

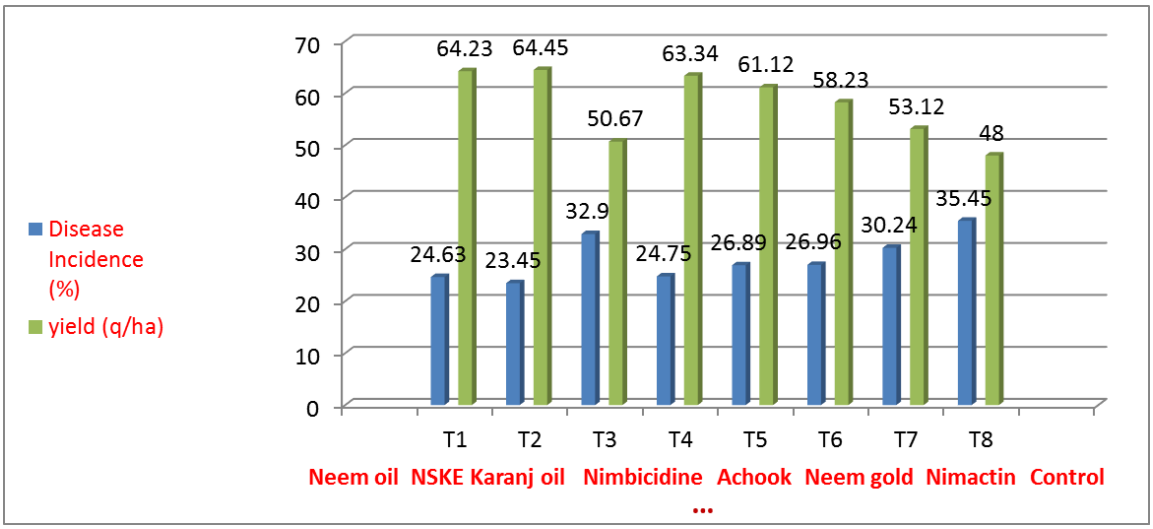

Fig 1: Effect of plant products on leaf curl disease incidence and fruit yield of chilli Rabi, 2015-16 cropping season

Similar results were reported by several earlier workers. Rashid and Khan (2000) [19], Harbant *et al.* (1999) [9], Singh and Sharma (1999) [9] demonstrated the use of botanicals, milk or cow urine in reducing the incidence of insect vectors, reducing viral disease of crops and improvement of yield. The influence of neem products in increasing the chilli yield was earlier reported by Smitha (2002) [25], Varghese (2003) [31] and Gundannavar (2007) [7]. They reported that neem based chemicals performed better and hence are best alternatives to RPP with on par/higher chilli yield. Similarly, Ukey and Saroda (2001) [28] reported that the application of NSKE alone also registered higher chilli yield. Similarly, neem derivatives viz., neem oil, Comnhoxcomnol Nekhex, Repelin and orgocide proved their superiority by recording least percent virus transmission and highest percent aphid mortality (Mariappan *et al.*, 1993) [13]. Among the various indigenous material used for the control of thrips and mites NSKE (0.5%) + Nimbicidine (2ml /lit) found best treatments and gave higher chilli yield (10.64q/ha), thrips (0.4 LCI/plant) and mites (0.7 LCI/plant) control followed by NSKE (1%) (0.5 LCI/plant) and 0.8 LCI/plant for thrips and mites). The effectiveness of neem oil against chilli thrips was reported by Mallikarjuna Rao *et al.* (1999). They found that as seedling root dip one per cent neem oil emulsion was effective against chilli thrips, S. dorsalis. Amongst the neem products experimented in the field, Neem gold ® (3%) and NO (3%) were promising (Naik *et al.*, 2004).The botanicals neem gold (3 ml/l), Vitex 5 percent and Clerodendron 5 percent were effective against yellow mite in chilli but were inferior to chemicals when applied only once (Subba Rao *et al.*, 2007)

[26]. Chakraborti (2000) [4] reported higher number of fruits per plant with neem based insecticides. Similar results of reduced Leaf Curl Index (LCI) by the spray of botanicals, neem products and indigenous materials were also reported by Bagle (1988) [3], Smitha (2002) [25], Varghese (2003) [30] and Mallapur *et al.* (2001) [11] in chilli crop. The efficiency of many bio-pesticides in the management of leaf curl disease and controlling of insect pests was well documented by many workers in India on chilli crop fields (Venzon *et al.*, 2008; Pandey *et al.*, 2010; Elvis *et al.*, 2014) [32, 16, 6]. The present investigation revealed that two sprayings of neem seed kernel extract (NSKE) 5% @5ml/lit. was found to be best treatment for checking vector activity of chilli leaf curl disease complex resulting minimum leaf curl disease incidence (23.45 percent) coupled with highest fruit yield of 64.45 q/ha during Rabi 2015-16 crop season than other treatments. The next effective treatment was two sprays of neem oil, which recorded disease incidence of 24.63 percent and yield of 64.23 q/ha. NSKE was also recorded 33.86 percent disease reduction over control followed by neem oil which recorded 30.53 percent disease reduction. More or less similar findings were also reported earlier by other workers. NSKE was most effective against white fly. It also indicated that NSKE was having both virucidal as well as insecticidal properties (Singh *et al.*, 1988; Raghupathi and Veeraragavathatham, 2002) [17]. This may be due to presence of complex constituent that are insecticidal. Of these, Azadiractin is known to cause a range of effects on a number of species of insects. NSKE was known to contain a number of biologically active principles (alkaloids) and for this reason it has shown repellency, anti-feedency, anti-growth activities and direct toxicity against a number of insects (Schmutterer, 1990; Chakraborty and Chatterjee, 1999) [20, 5]. Further, application of NSKE 5% @ 5ml/lit was highly economical which recorded cost-benefit ratio of 1:17.13 and net returned of Rs. 1,5543/- which recorded highest net return /ha among all the tested plant products. Maximum mean plant height, number of branches per plant, fruit length, fruit breadth, fruit weight were recorded by NSKE followed by spraying of Neem oil. These phenotypic characters were statistically significant. More or less similar finding was reported on the effects of biopesticides on yield attributing characters of chilli by Khalaequazzawan *et al.* (2016) [10]. They observed that bio pesticides showed significant effect on yield and yield attributing characters of chilli. But plant height was not statistically significant within treatments. Ahmed *et al.* (2001) [1] reported that neem oil application @ 5 ml/l recorded 34.28 percent reduction of chilli mite over control.

It was apparent from the evaluation of botanicals in field condition that botanicals effectively reduce the disease against as compared to control. On the whole, it can be concluded that among the tested plant products, NSKE found most effective bio-pesticides against vector activities followed by neem oil and Nimbicidine whereas Karan oil was found to be least effective. All the tested plant products significantly checked the vector activities and effectively reduced the leaf curl disease incidence as compare to control. Therefore, the investigation strongly recommends the application of NSKE against vector activities to reduce chilli curl disease complex.

Acknowledgement
The authors gratefully acknowledge Department of Plant Pathology, Birsa Agricultural University, Ranchi, Jharkhand for providing the required facilities and other necessary managements. The authors are also thanking all staff members of the Department for their help and support during the studies.

References

1. Ahmed K, Hanumantha Rao V, Purnachandra Rao P. Resistance of chilli cultivars to yellow mite, *Polyphagotarsonemus latus* Banks. Indian Journal of Agricultural Research. 2001; 35:95-99.
2. Anonymous. Index of Plant Virus Disease. Agricultural Head Book No. 307 U.S. Department of Agriculture, 1966, 446.
3. Bagle BG. Efficacy of varying dosages of insecticides against thrips, *Scirtothrips dorsalis* Hood in chilli and its effect on yield. In: National Symposium on Integrated Pest Management (IPM) in Horticultural Crops, Bangalore, 1988, 108-110.
4. Chakraborti S. Neem based integrated schedule for the control of vectors causing apical leaf curling in chilli. Pest Mngt. Econ. Zoolo. 2000; 8 (1):79-84.
5. Chakraborti S, Chatterjee ML. Effect of azadirachtin and other neem pesticides on survival, growth and development of the red cotton bug, Dysdercus koenigii Fabr. Journal of Insect Science. 1999; 12(2):129-133.
6. Elvis Asare-Bediako1, Albert Addo-Quaye, Appiah Bi-Kusi. Comparative Efficacy of Plant Extracts in managing Whitefly (*Bemisia tabaci* Gen) and Leaf curl Disease in Okra (*Abelmoschus esculentus* L). American Journal of Agricultural Science and Technology. 2014; 2(1):31-41.
7. Gundannavar KP. Vector-leaf curl relationship and development of organic package for the management of chilli (Cv. *Bydagi*) pests. Ph.D. Thesis, University of Agricultural Sciences, Dharwad, 2007.
8. Gurjar MS, Ali S, Akhtar M, Singh S. Efficacy of plant extracts in Plant disease management. Agricultural Sciences. 2012; 3(3):425-433.
9. Harbant S, Korpraditskul V, Singh H, Vichai KPP, Singh, Saxena RC. Evaluation of some plant extracts for the control of *Colletotrichum capsici* (SYD.) Butter and Bisby, the causal agent of chilli anthracnose. *Azadirachta indica* A. Juss. Mara Inst of Tech, Malaysia. 1999; 12:131-138.
10. Khalequazzaman KM, Naznin S, Khair A. Effect of Biopesticides in controlling leaf curl virus of chilli. Asia Pacific Journal of Energy and Environment. 2016; 3(1):29-34.
11. Mallapur CP, Kubsad VS, Hulihali UK. Effect of ethion on mites and thrips causing leaf curl in chilli. Karnataka J Agric. Sci. 2001; 14(3):668-670.
12. Mallikarjuna Rao CN, Muralidhara Rao G, Tirumala Rao K. Efficacy of neem products and their combinations against chilli thrips Scirtothrips dorsalis Hood. Pestology. 1999; 23(3):10-12.
13. Mariappan V, Jayaltrshimi V, Dileep L, Kumar Samuel. Management of Chilli Mosaic Virus Disease by Using Plant Products. Neem for the Management of Crop Diseases Associated Publishing Company, New Delhi, India, 1993, 145-155.
14. Naik DJ, Tyagaraj NE, Kumar D, Madaiah M, Dinesh, Belavadi VV. Effect of neem based insecticides for the control of thrips and shoot and capsule borer of cardamom. In: Abstracts of pa-Plant products for pest and disease management 8 pers, Symposium on Spices and Aromatic Crops: Commercialization of Spices, Medicinal

and Aromatic Crops, Calicut. Indian Society for Spices, Calicut. 2004; (1-2):24-25
15. Nene YL. A survey of viral diseases of pulse crops in Uttar Pradesh. G.B. Pant. Univ. Agric. Technol. Pantnagar Res. Bull. 1972; 4:911.
16. Pandey SK, Mathur AC, Srivastav M. Management of Leaf curl Disease of Chilli (*Capsicum annuum* L.), International Journal of Virology. 2010; 6(4):246-250.
17. Ragupathi N, Veeraragavathatham D. Management of chilli mosaic virus disease using insecticides, botanical and barrier crop. South Indian Horticulture. 2002; 50:273-275.
18. Rajasri M, Reddy GPV, Krishnmurthy M, Prasad VD. Bioefficacy of certain newer insecticides and neem products against chilli pest complex. Indian J Cocoa Arecanut Spices. 1991; 15:42-44.
19. Rashid A, Khan MA. Evaluation of antagonistic microbes and bio- insecticides against leaf curl virus and bacterial blight of cotton. Pakistan J Phytopath. 2000; 12(2):137-141.
20. Schmutterer H. Properties and potential of natural pesticides from the neem tree, Azadirachta indica. Annual Review of Entomology. 1990; 35:271-297.
21. Senanayake DMJB, Mandal B, Lodha S, Verma AA. First report of chilli leaf curl affecting chilli in India. J Food Agric. Environ. 2006; 4:171-174.
22. Shanker JS, Parmar BS. Recent developments in botanicals and biopesticides. Indian J Plant Prot. (1999). ; 27:139-154.
23. Singh SS, Sharma RK. Control trial on chilli mosaic virus after inhibiting their infectivity by leaf juices of some angiospermic plants. J Living World. 1999; 6(2):18-21.
24. Singh UC, Reeti S, Nagaich KN. Reaction of some promising chilli varieties against major insect pests and leaf curl disease. Indian Journal of Entomology. 1998; 60(2):181-183.
25. Smitha MS. Management of yellow mite, *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae) on chilli. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad, 2002.
26. Subba Rao AK, Reddy S, Ramesh P. Protecting soil health under conventional agriculture and organic farming. Green Farming. 2007; 1(1):1-9.
27. Tiwary A, Kaushik MP, Pandey KS, Dangy RS. Adoptability and production of hottest chilli variety under Gwalior agroclimatic conditions. Current Science. 2005; 88(10):1545-1546.
28. Ukey SP, Saroda SV. Management of fruit borer and bred borer of chilli through integrated approach. Punjab Rao Deshmukh Krishi Vidyapeeth Research Journal. 2001; 25(1):24-29.
29. Vanisree K, Upendhar S, Rajasekhar P, Ramachandra Rao G, Srinivasa Rao V. Field evaluation of certain newer insecticides against chilli thrips, *Scirtothrips dorsalis* (Hood). Science Park Research Journal. 2013; 1(20):1-13.
30. Varghese TS. Management of thrips, *Scirtothrips dorsalis* (hood) and mite, *Polyphagotarsonemus latus* Banks on chilli using biorationals and imidacloprid. M.Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka, India, 2003.
31. Venkatesh HM, Muniappa V, Ravi KS, Prasad KPR. 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 Thrusts, Bangalore, India. 1998, 15-17, 111-117.
32. Venzon M, Consolac-ao RM, Adrian Jose MR, Silveira DV, Rondinelli, Angelo P. Acaricidal efficacy of neem against *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae). Crop Prot. 2008; 27:869-872.