Persian Journal of Acarology, 2016, Vol. 5, No. 3, pp. 229–237.

Article

Varietal preference and population dynamics of *Notacaphylla chinensiae* Mohanasundaram and Singh on litchi in West Bengal, India

Pranab Debnath and Krishna Karmakar*

Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, Nadia, West Bengal, India; E-mails: pranab.bckv@gmail.com, acarikarmakar@rediffmail.com

* Corresponding author

Abstract

The litchi white rust mite, *Notacaphylla chinensiae* Mohanasundaram and Singh, 1988 is a pest of litchi in West Bengal, India. Study on population dynamics, sensitiveness of litchi cultivars towards the mite was conducted between 2009 and 2011. The mite remains active on litchi plants throughout the year in West Bengal, reaching the highest population densities (1300 to 1500 mites/cm^2 leaf) in winter (January/ February). Population densities of *N. chinensiae* was negatively correlated with monthly mean of the maximum temperature (–0.492), minimum temperature (–0.785), rainfall (–0.665) and minimum humidity (–0.829). Among 11 litchi cultivars, the highest mean population throughout the year was recorded on Nafarpal (440–584 mites/cm^2 leaf) followed by Elaichi (431–597 mites/cm^2 leaf), Bombai (437–600 mites/cm^{2}leaf) and Seedless late (444–594 mites/cm^2 leaf), whereas the lowest was assessed on Purbi (146–167 mites/cm^2 leaf) followed by Muzaffarpur (148–184 mites/cm^2 leaf).

Key words: Cultivar susceptibility; litchi; India; weather parameters; white rust mite.

Introduction

Litchi (*Litchi chinensis* Sonnerat, Sapindaceae) is an important evergreen fruit crop of the Asian-Pacific region. Leading countries in litchi production are China, India, Thailand, Australia and Vietnam, where more than 95% of world production occurs (Mitra and Pathak 2010). Litchi is believed to have originated in southern China then have been introduced to India in the 18th century (Singh and Babita 2002). India produces annually 433,200 tons of litchi fruits in about 60,000 hectares (Mitra and Pathak 2010), mostly in Assam, Bihar, Chattrisgarh, Jharkhand, Orissa, Punjab, Uttarakhand, Tripura and West Bengal States (Anonymous 2010). In the latter State, litchi is grown in the districts of Murshidabad, Nadia, 24 Parganas (North and South), Hooghly and Howrah (Ghosh *et al.* 2001).

The litchi erineum mite, *Aceria litchii* (Keifer), is widely known as a serious pest of litchi in India (Butani 1977), where it causes profuse formation of erinea on the lower surfaces of leaves, twigs and tender fruits (Mathur 1972; Gupta 1980), leading to yield losses. Another eriophyid mite, *Notacaphylla chinensiae* Mohanasundaram and Singh, (1988) was described based on specimens collected on litchi in West Bengal. This is a

vagrant mite that causes white rusting on the upper surface of the leaf. Despite the agricultural importance of this mite, till date its impact on litchi plants and the yield loss caused by it has not yet been evaluated.

Observations conducted in commercial litchi plantations and contacts with growers of the Indo-Gangetic Plane of West Bengal in the early 2000's indicated *N. chinensiae* to be associated with major whitish discoloration of the upper surface of mature litchi leaves. The present study was conducted with the objectives: to evaluate its ecological details, including the evolution of the symptoms along the season, the population dynamics of the species and its abundance on different cultivars.

Materials and methods

Population dynamics

The study was conducted at Moundouri Farm (22° 56′ N; 88° 31′ E), of Bidhan Chandra Krishi Viswavidyalaya, Moundouri, Nadia, West Bengal, India. The study was conducted in one-hectare litchi plot of plants of the Bombai cultivar (the most susceptible cultivar according to our preliminary observations), about 15 year-old and with about 5 m high. Samples consisted of moderately mature leaves taken monthly from around the plant canopy, about 4 m from ground level between August 2009 and July 2011. Each sample consisted of 40 matured leaves plucked from 10 plants taking 4 leaves from four directions of each plant. Leaves of each tree were placed in paper bag separately for transport to the laboratory, where they were kept under refrigeration (about 5–8°C) until examination under a stereomicroscope within two days. The mite number of all post-embryonic stages was determined in a cm^2 area on the central part of the upper surface of each collected leaf. To study the co-relationship of the mite population with the weather parameters, daily maximum and minimum temperatures, relative humidity and rainfall were taken from a meteorological station of All India Co-ordinate Research Project on Agricultural Meteorology, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, about 5 km far from the litchi field.

Cultivar susceptibility

Eleven cultivars including Muzaffarpur, Nafarpal, Elaichi, Deshi, Kasba, Purbi, Bedana, Bombai, Rose Scented, Early large red and Seedless late were compared in relation to their susceptibility to the attack of *N. chinensiae*. Each cultivar was planted in a plot of about 0.1 hectares, with a spacing of 5 m between plants. Neighbouring plots were 5 m far from each other. Plants of all cultivars were about 15 year-old with about 5 m high. Horticultural practices were the same for all plots. Each experimental unit consisted of 20 neighbouring trees within the plot of each variety. The sampling for estimation of mite population has been done at monthly interval (Tables 2 and 3). At each sampling date, the fifth or sixth leaf from the tip of each four randomly taken twigs from each tree of the experimental unit were collected. Altogether, 40 leaves were considered for counting the mean mite population of each cultivar. Comparison between cultivars was done using a randomized block design, with three replicates for each cultivar. Duncan's multiple range test (Duncan 1955) was used for the comparison between mite density means for each cultivar.

Results and discussion

Population dynamics

Notacaphylla chinensiae was found throughout the duration of the study. The lowest population density (24 mites/cm^2 leaf in 2010 and 12 mites/cm^2 in 2011) occurred at the end of the summer and during the rainy season, August-October (Fig. 2). Then, the population increased uniformly until the peak population density (1505 mites/cm^2 leaf in 2010 and 1339 mites/cm^2 leaf in 2011) which was reached in the middle of the winter and during the dry season, January-February, when prevailing temperature (maximum, 24.6°C and minimum, 9.7°C), relative humidity (maximum, 94.8% and minimum, 47.6%) and daily mean rainfall (0.3 mm) were recorded. The mite population also declined again uniformly towards August-October when the ambient temperature (maximum, 32.9°C and minimum, 24.3°C), relative humidity (maximum, 96.1% and minimum, 69.4%) and daily mean rainfall (9.7 mm) were recorded (Table 1). This pattern of population dynamic is similar to what was reported by Das and Sengupta (1958) for the purple tea mite, *Calacarus carinatus* (Green), in Assam, India and pink mite, *Acaphylla theae* (Watt), on tea in Tamilnadu, India. Population densities of *N. chinensiae* was negatively correlated with monthly mean maximum temperature (R= –0.492), minimum temperature (R= –0.785), rainfall (R= –0.665) and minimum relative humidity (R= –0.829). No significant correlation was observed between the population densities and maximum relative humidity (Table 1). Population density of *N. chinensiae* negatively co-related with the temperature, relative humidity and rainfall as it is observed to be maximum during winter months when there is minimum temperature, rainfall and relative humidity recorded. These correlations indicate that this mite prefers to reproduce largely under low temperature and atmospheric moisture like some other leaf vagrant eriophyids. These observations were in conformity with the earlier observation of Muraleedharan and Chandrasekaran (1981), who established that the high humidity and rainfall were the most important factors adversely affecting the population of *C. carinatus* and *A. theae*.

Though *C. carinatus* and *A. theae* are not associated with litchi, they have been compared with *N. chinensiae* for the similarity of their habit, behavior and damaging status to the respective crops. On the contrary, *Aceria litchii* infests litchi plant, causing high economic loss of yield but its habit, behaviour and damaging pattern distinctly different from that of *N. chinensiae*. *Aceria litchii* is a serious pest of litchi in major litchi growing states like Assam, Bihar, Chattrisgarh, Jharkhand, Orissa, Punjab, Uttarakhand infesting young leaves and even developing fruits during late winter on which cause afterward a velvety chocolate brown erineum when population of *N. chinensiae* start to dwindle.

Throughout the duration of the study, the mites were observed to inhabit both leaf surfaces. When rainfall is at a minimum coupled with low temperature, the high mite densities (Fig. 1A) form a white rusty appearance on the upper leaf surface (Fig. 1B). When rainfall is at a maximum and temperature is higher, mites were found only on lower leaf surface, occupying restricted spots, without producing any prominent symptoms.

No information in the literature referred to the population dynamics of *N. chinensiae* and their effects. Huang *et al.* (1989) registered the symptoms caused by *Acaspina litchii* in Taiwan; the illustrated symptoms appear to be very similar to those observed in the present study. Huge mite densities, presence of cast skins and leaf

alterations caused by the mite might have a negative influence on the photosynthetic activity of litchi plant which needs to be ascertained such as the impact on the yield.

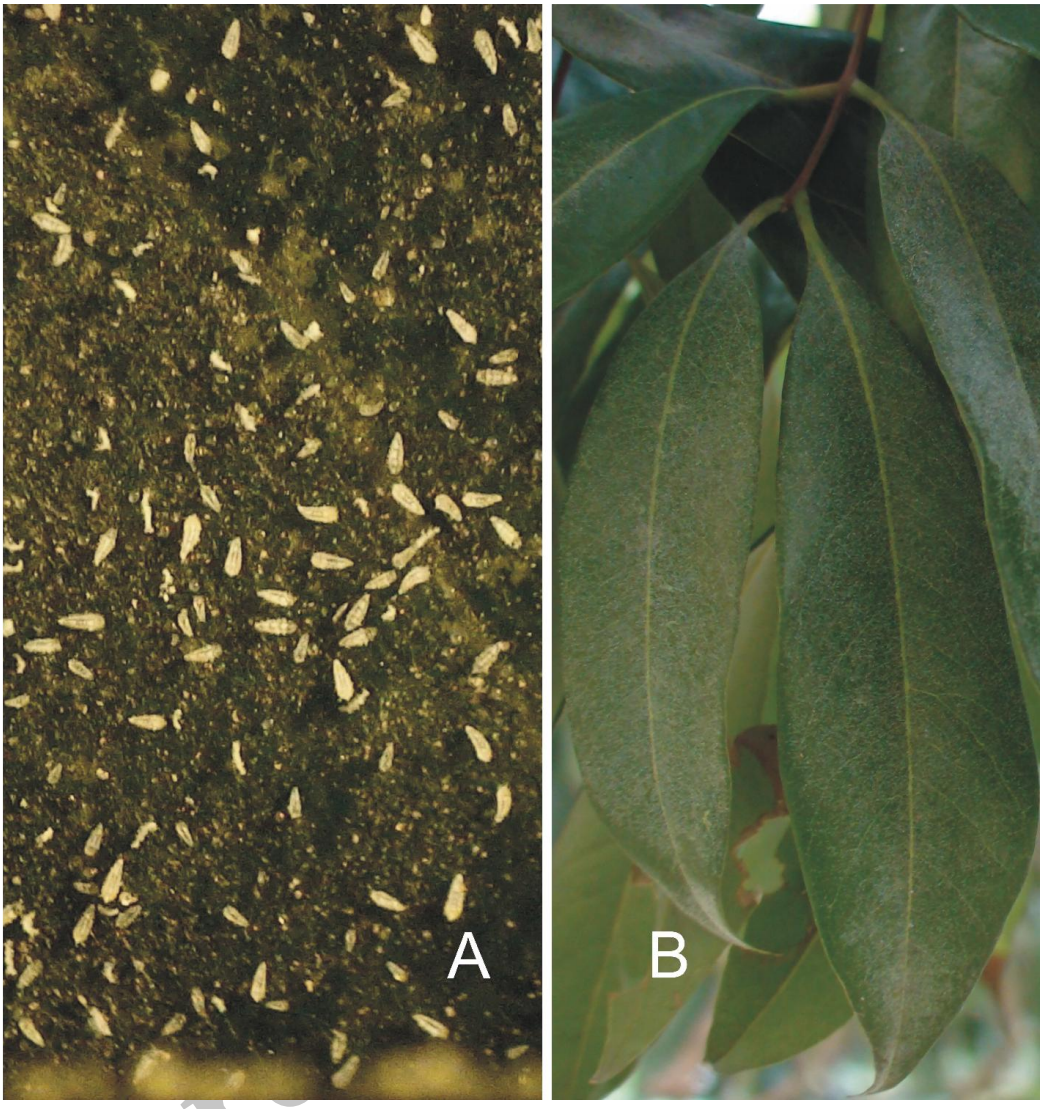

Figure 1. *Notacaphylla chinensiae* Mohanasundaram and Singh – A. Live mites of different stages and their exuvia; B. symptoms of infestation on litchi leaves.

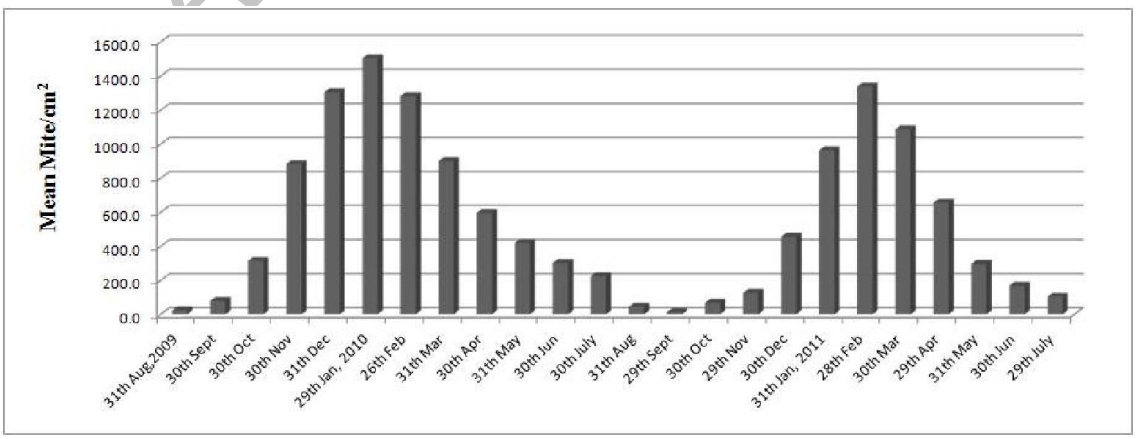

Figure 2. Population dynamics of *Notacaphylla chinensiae* Mohanasundaram and Singh on litchi (variety: Bombai).

Table 1. Correlation coefficients (*r*) with the occurrence of mite population and weather parameters on litchi plants.

Months	Mean no. of mite/cm^2	Temperature (°C)		Relative humidity (%)		Daily mean Rainfall (mm)
		Max.	Min.	Max.	Min.	
August, 2009	24.3	32.5	25.8	97.7	81.1	13.8
September	79.8	32.9	25.9	98.0	81.9	6.2
October	314.1	31.9	21.9	96.9	63.6	2.1
November	883.7	29.9	18.0	97.1	54.6	0.5
December	1305.3	26.3	11.6	97.9	45.9	0.0
January, 2010	1505.7	23.7	8.9	93.0	53.3	0.0
February	1282.2	29.2	14.6	96.4	43.8	0.3
March	901.2	36.5	21.8	95.1	41.4	0.0
April	597.5	37.6	26.7	87.7	48.8	1.3
May	420.7	35.4	25.9	89.6	62.2	4.1
June	302.0	34.3	26.7	91.6	70.9	4.6
July	225.4	33.1	26.6	92.9	73.2	4.6
August	44.9	32.9	26.7	94.6	75.0	5.7
September	12.9	32.7	25.9	96.1	76.7	9.7
October	69.1	32.5	24.3	94.2	69.4	3.1
November	126.1	30.9	19.9	92.0	55.4	0.0
December	456.8	25.3	12.1	94.4	67.3	0.6
January, 2011	963.5	24.6	9.7	94.8	47.6	0.0
February	1339.1	29.4	14.1	93.3	39.1	0.0
March	1087.6	33.6	20.2	89.6	45.7	2.1
April	655.8	37.3	25.5	89.8	41.0	0.0
May	297.3	35.0	25.7	89.1	61.1	7.8
June	168.5	35.6	27.4	89.5	64.5	1.6
July	104.2	32.8	26.5	94.2	76.3	7.3
Pearson's *r*		– 0.492*	– 0.785**	0.025	– 0.829**	– 0.665*

* Significant at 0.05 level of probability; **Significant at 0.01 level of probability; Population size (n=24)

Cultivar Susceptibility

Significant differences were observed among cultivars in 2009 (Table 2) and 2010 (Table 3). In both years, highest population densities were observed on Nafarpal, Elaichi, Bombai and Seedless Late with 440-584, 431-597, 437-600 and 444-594 mites/cm^2 leaf, respectively. In contrast, the lowest densities were found on Purbi and Muzaffarpur with 146-167 and 148-184 mites/cm^2 leaf, respectively. Muzaffarpur is preferred by the producers for its early flowering, profuse bearing habit and good taste of the fruits (Chadha and Rajpoot 1969). Besides, palp/seed ratio, total soluble solids, total soluble sugar/acidity ratio and total sugar content increased while acidity and moisture content is reduced during its ripening (Singh and Abidi 1986). The present observation revealed that Bombai, Elachi and Nafarpal possessing wide leaves and bushy appearance are preferred to mite infestation while, in contrast, Purbi, Muzaffarpur and Desi are non-preferred to mite. Hence, these cultivars may be recommended to the growers for successful cultivation of litchi for minimum mite infestation. The wide leaves and bushy appearance of plant might be the cause of higher infestation of mite as compared to the cultivars with narrow leaves and sparse appearance. However, these have yet to be confirmed.

Table 2. Population dynamics (mean no. of mites/cm^2 leaf area) of *Notacaphylla chinensiae* on litchi varieties during 2009 to 2010.

	14.08.2009	15.09.2009	15.10.2009	16.11.2009	14.12.2009	15.01.2010	15.02.2010	16.03.2010	15.04.2010	14.05.2010	14.06.2010	15.07.2010	Mean
Muzaffarpur	5a	22a	62a	273b	341a	565a	458a	194a	98a	84a	58a	47a	184
Nafarpal	23d	64c	284c	64f	1216e	1478c	1140c	816de	556c	314c	273d	202e	584
Elaichi	21d	69c	283c	670f	1254e	1444c	1144c	817de	541c	383c	303d	232e	597
Deshi	11b	49b	134b	365d	524b	959b	686b	460b	300b	184b	153b	101b	327
Kasba	14b	44b	133b	316c	689c	949b	690b	516b	304b	193b	189c	105b	345
Purbi	3a	21a	67a	116a	332a	558a	432a	225a	85a	77a	52a	39a	167
Bedana	12b	48b	146b	371d	716c	950b	696b	675cd	311b	196b	160bc	148d	369
Bombai	23d	64c	298c	653f	1246e	1471c	1200c	831de	537c	348c	302d	225e	600
Rose	16bc	49b	124b	457e	858d	959b	659b	573bc	264b	187b	167bc	142cd	371
Early large	13b	47b	134b	356d	550b	923b	689b	536bc	289b	204b	180bc	111bc	336
Seedless	21cd	64c	281c	639f	1263e	1454c	1145c	858e	519c	353c	291d	235e	594
F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	
CD 5%	0.61	0.45	1.48	1.07	1.48	1.72	3.06	2.93	1.42	2.24	1.21	1.45	
Sem±	0.20	0.15	0.50	0.36	0.50	0.58	1.03	0.99	0.48	0.76	0.41	0.49	

Same letters denote homogeneous means in Duncan's Multiple Range Test.
CD 5% = Critical Difference, significant at 5% level of probability; Sem (±) = Standard error of mean

Table 3. Population dynamics (mean no. of mites/cm^2 leaf area) of *Notacaphylla chinensiae* on litchi varieties during 2010 to 2011.

	16.08.2010	15.09.2010	18.10.2010	15.11.2010	15.12.2010	1.01.2011	16.02.2011	15.03.2011	15.04.2011	16.05.2011	15.06.2011	15.07.2011	Mean
Muzaffarpur	14a	13a	30a	42a	117	239	642	432	115	55a	51a	23a	148
Nafarpal	48f	26f	64d	119	417	947	140	104	683	222	195	112	440
Elaichi	48f	22e	61d	124	406	909	140	102	638	230	192	114	431
Deshi	34b	15b	37b	74b	167	621	834	684	486	145	118	54b	272
Kasba	39c	17c	35b	76b	189	617	881	644	492	143	128	53b	276
Purbi	13a	11a	28a	45a	116	236	643	415	110	58a	54a	21a	146
Bedana	37b	17c	39c	78b	196	626	934	660	477	150	124	51b	282
Bombai	46e	22e	69d	126	414	942	142	103	638	219	193	113	437
Rose	38b	17c	38c	73b	178	614	885	638	476	143	124	51b	273
Early large	30b	14b	34a	70b	169	621	894	674	469	142	128	50b	275
Seedless	45d	20d	62d	121	414	980	144	106	634	223	194	112	444
F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	
CD 5%	0.65	0.44	0.62	0.71	0.95	0.91	0.92	1.06	1.47	0.34	0.54	0.83	
Sem±	0.22	0.15	0.21	0.23	0.32	0.31	0.31	0.36	0.49	0.11	0.18	0.28	

Same letters denote homogeneous means in Duncan's Multiple Range Test.
CD 5% = Critical Difference, significant at 5% level of probability; Sem (±) = Standard error of mean

Acknowledgements

The authors are grateful to the Indian Council of Agricultural Research, New Delhi and to the Vice Chancellor and Director of Research, Bidhan Chandra Krishi

Viswavidyalaya for providing infrastructure facilities. We are grateful to Prof. C.H.W. Flechtmann and Prof. G. J. de Moraes, USP, ESALQ, Piracicaba, Brazil, as well as to Prof. J. W. Amrine, West Virginia University, Morgantown, USA for helping us by providing information, identification, and preparation of manuscript. We gratefully acknowledge Dr. A. Samanta, Scientist under AICRP on Sub-Tropical Fruits, BCKV, Kalyani, for extended help during conduction of the study and to Dr. V. Prasad, for his continuous inspiration and support.

References

Anonymous (2010) Indian Production of Litchi. National Horticulture Board. Available from: www.agriexchange.apeda.gov.in/india production (accessed on 5 May 2012).

Butani, D.K. (1977) Pests of litchi in India and their control. *Fruits*, 32: 269–271.

Chadha, K.L. & Rajpoot, M.S. (1969) Studies on floral biology fruit set and its relation and quality of some litchi varieties. *Indian Journal of Horticulture*, 26: 124–129.

Das, G.M. & Sengupta, M. (1958) Observations on the pink mite *Acaphylla theae* (Watt) Keifer, of tea in North-East India. *Journal Zooogical Society of India*, 10: 39–48.

Duncan, D.B. (1955) Multiple range and Multiple F-Test. *Biometrics*, 11: 1–42.

Ghosh, B., Mitra, S.K. & Sanyal, D. (2001) Litchi cultivars of West Bengal, India. *Acta Horticulturae*, 558: 107–113.

Gupta, S.K. (1980) Some observations on litchi leaf curl disease in West Bengal. *Science & Culture*, 46(7): 265.

Huang, T., Huang, K.W. & Hong, I. J. (1989) Two species of eriophyid mites injurious to litchi trees in Taiwan. *Chinese Journal of Entomology*, *Special Publication*, 3: 57–64.

Mathur, S.N. (1972) Efficacy of pesticides on the control of litchi mite, *Aceria litchii. Third International Symposium of Sub Tropical and Tropical Horticulture*, *Bangalore*, 11: 589.

Mitra, S.K. & Pathak, P.K. (2010) Litchi production in the Asia-Pacific Region. *Acta Horticulturae*, 863: 29–36

Mohanasundaram, M. & Singh, P. (1988) A new genus and species of eriophyid mite from West Bengal (Eriophydae: Acari). *Entomon*, 13(3 & 4): 259–261.

Muraleedharan, N. & Chandrasekharan, R. (1981) Observations on seasonal variations of *Acaphylla theae* Keifer and *Calacarus carinatus* (Green) (Acarina: Eriophyidae) in a tea field at the Annamalies (South India). *Pestology*, 5(6): 11–15.

Singh, A. & Abidi A.B. (1986) Level of carbohydrate fractions and ascorbic acid during ripening and storage of litchi cultivars. *Indian Journal of Agricultural Chemistry*, 19: 192–202.

Singh, H.P. & Babita, S. (2002) Lychee production in India. Paper presented at: Expert Consultation May 2001. Lychee Production in the Asia-Pacific Region; *Food and Agricultural Organization of the United Nations, Regional Office for Asia and the Pacific,* Bangkok, Thailand, pp. 106–113.

Received: 27 January 2016
Accepted: 10 May 2016
Published: 15 July 2016

ترجیح رقم و پویایی جمعیت *Notacaphylla chinensiae* Mohanasundaram and Singh روی لیچی در بنگال غربی، هند

پراناب دبناث و کریشنا کارمکار*

گروه حشره‌شناسی کشاورزی؛ بیدهان چاندرا کریشی ویسواویدیالا یا، موهانپور- ۷۴۱۲۵۲، نادیا، بنگال غربی، هند؛ رایانامه‌ها: pranab.bckv@gmail.com ، acarikarmakar@ rediffmail.com

* نویسندهٔ مسئول

چکیده

کنهٔ زنگار سفید لیچی، *Notacaphylla chinensiae* Mohanasundaram and Singh, 1988 آفت لیچی در بنگال غربی هند است. پویایی جمعیت و حساسیت رقم‌های لیچی به کنهٔ زنگار سفید بین سال‌های ۲۰۰۹ و ۲۰۱۱ مطالعه شد. کنه روی گیاه لیچی در تمام طول سال در بنگال غربی فعال‌اندو در زمستان (ژانویه/فوریه) به بیشترین انبوهی جمعیت (۱۳۰۰-۱۵۰ کنه در سانتی‌مترمربع برگ) می‌رسد. انبوهی جمعیت *N. chinensiae* با میانگین ماهانه بیشینهٔ دما (۰/۴۹۲-)، کمینهٔ دما (۰/۷۸۵-)، بارش (۰/۶۶۵-) و کمینهٔ رطوبت (۰/۸۲۹-) رابطه منفی داشت. بین ۱۱ رقم لیچی بیشترین میانگین جمعیت در تمام طول سال روی رقم نافارپال (۴۴۰-۵۸۴ کنه در کنه در سانتی-مترمربع برگ، پس از آن الائیچی (۴۳۱-۵۹۷ کنه در سانتی‌مترمربع برگ)، بمبئی (۴۳۷-۶۰۰ کنه در سانتی‌مترمربع برگ) و سیدلس لیت (۴۴۴-۵۹۴ کنه در سانتی‌مترمربع برگ) به ثبت رسید در حالی‌که کمترین آن روی رقم‌های پوربی (۱۴۶-۱۶۷ کنه در سانتی‌مترمربع برگ) و پس از آن رقم مظفرپور (۱۴۸-۱۸۴ کنه در سانتی‌مترمربع برگ) ارزیابی شد.

واژگان کلیدی: حساسیت رقم‌ها؛ لیچی؛ هند؛ آماره‌های آب و هوایی؛ کنهٔ زنگار سفید.

تاریخ دریافت: ۱۳۹۴/۱۱/۷

تاریخ پذیرش: ۱۳۹۵/۲۱۴

تاریخ چاپ: ۱۳۹۵/۴/۲۵