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Structure and ecology of *Cephaleuros virescens* Kunze and its relationship with *Aceria litchii* Keifer (Prostigmata : Acari) in forming litchi erineum

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The purpose of this study was to characterize the deformities in litchi leaves that are associated with litchi leaf curl or litchi erineum. This plant response is partially due to attack by *Aceria litchii* Keifer. The erineum appears on litchi leaves as young vegetative thalli of parasitic alga with few erect branches which contain a little visible haematochrome pigment. During asexual reporduction, the thalli become velvety in appearance and cover large areas of the host leaf in the area of infection. Structural studies revealed that the velvety appearances is created by abundant setae (sterile trichome) and fertile branches. The ring spots on the upper surface of the leaves contain simple plasmodesmata surrounded by a ring of thickened wall material. At later stages, the ring spots become white as they are attacked by obiligately foliicolus lichen known as "Strigula". The seasonal incidence study of mite showed that the maximum number of infested leaves were in the eastern side. Different mechanical treatments for the artificial induction of erineal structure showed the development of ring spots 45th day after treatment on the upper surface which later dries up.

Key words : Litchi erineum, *Cephaleuros virescens*, ecology

INTRODUCTION

The *Aceria litchii* Keifer occurs on the under surface of litchi leaves causing a velvety, caushion like structure on the ventral side. Thousands of mites remain within this structure. Joppson *et al.* reported that the velvety growth was the result of extension of leaf hairs. But Somchoudhury *et al.* (1989) and Sharma (1991) showed that the velvety mass was because of the parasitic algal filament, viz., *Cephaleuros virescens* Kunze. According to the authors in the foregoing, the mite punctures the ventral side of the litchi leaf for feeding. Through the puncture site, the opportunist algal spore moving in the air took entry within the leaf tissue and with the help of the toxin injected by the mite due to course of

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feeding resulting in the appearance of proliferated velvetly growth. They also established that on the dorsal surface *Cephaleuros* alone causes irregular ring spots which can not spread due to lack of mite infestation. The parasitic alga on the first appearance was silvery white gradually it become light green followed by deep green, light brown, deep brown and finally black in colour which indicated the death of the algal filaments. The infested portion of the litchi leaves contains more amount of 'Fe' than the uninfested area, indicating that the parasitic algae used to draw huge amount of 'Fe' for the formation of heamatochrome essential for their development (Somchoudhury *et al.*, 1989). But according to Sharma (1991), the mite infestation on leaves has no influence in causing this malady. And he showed that the application of crushed leaves bearing erineal structure are capable of producing velvety symptoms on fresh leaves after three months of application. The genus *Cephaleuros* belongs to the class Chaetophorales which includes the other gerera like *Cephaleuros*, *Phycopeltis*, *Stomatochroon* and *Trentipholia.* These four genera are distinguished by differences in morphology and, to some extent, the mode of interaction with vascular host plant. All members of this family are filamentous and subaerial, some occurring on inanimate substrates such as rock and wood, others on vascular plant hosts and especially abundant in tropical and subtropical region of the world. The key characteristics of the family are, firstly, there are cytoplasmic accumulations of the yellow to orange colour pigment known as haematochromes. Secondly, the cell walls tend to be specially thick compared to those of may aquatic green algae. Thirdly, the zoosporangia absciae and are dispersed by wind, rain, insects, arachnids (mites). The extent of interaction of *Cephaleuros* with the vascular plant host is most easily visible and most clearly documented. *Cephaleuros* occurs in tropical and subtropical regions and is an epiphyte or parasite of numerous species of vascular plant hosts, as for example, Holcomb (1975) reported *C. virescens* Kunze on more than 115 species of hosts in Louisiana, and Batista and Lima (1949) cited 448 hosts in Brazil. Yadav and Srivastava (1957) reported 85 angiospermic plants to be infested with *Cephaleuros.*

The alga can grow on leaves, young stems, and fruits and is considered to be a pathogen of crop plants such as coffee, citrus, *Anacardium, Eucalyptus*, members of Laureceae, *Jambonia vulgaris, Mangifera indica, Acrus sapota, Thea chinensis, Litchi chinensis* (Winston 1938), Wellman 1965, 1972; Golato, 1970; Roth, 1971; Vidhyasekaran and Parambaramani 1971a, 1971b, Premila *et al.*, 1990; Yadav 1953, 1955; Saxena 1962; Jose and Choudhury, 1980). The term "red rust" and "algal rust" have been applied to *Cephaleuros* infections and have caused some confusion by connotating fungal diseases.

Till today 3 species of *Cephaleuros* are known from Indian sub-continent viz. *Caphaleuros livis* (grows well on the leaf surface of *Psidium guajava*), *C. parasiticus* (grows on the leaf surface of *Alnus nepalensis*), and *C. virescens* (grows on *Anacardium* sp., *Eucalyptus* sp., *Mangifera indica, Acrus sapota, Anthocephalus kadamba, Thea sinensis* etc. (Santra, 1988). Singh (1986) first reported the presence of *C. virescens* Kunze in litchi leaves. Later, Somchoudhury *et al.* (1989) and Sharma (1991) confirm the finding.

MATERIALS AND METHODS

Seasonal incidence of Aceria litchii *Keifer*

Infested leaves were graded according to degree of infestation based on the size of the erineal structure on the leaf surface. Grades were as follows :'A' typed leaves - more than

75% of the total leaf area covered with erieal structure;

'B' typed leaves - 50 to 75% of the total leaf area covered with erineal sturcture; 'C' typed leaves - 25 to 50% of the total leaf area covered with erineal structure; and 'D' typed leaves - 1 to 25% of the total leaf area covered with erineal structure.

For grading, 400 leaves were marked randomly on the tree, 100 from each cordinal direction. There were three such plants representing a total of 1200 leaves. The observation were taken at 15 days interval from May to November, 1991 and 1992.

Artificial production of symptoms

To produce symptoms by *Cephaleuros* on litchi leaves either on the dorsal or on the ventral side, attempts were made to invite opportunist algal pathogen on the desired site of a leaf. For this purpose different procedures were taken into consideration viz., i) laceration-both on the upper and lower surfaces of the leaves with carborandum powder; ii) attaching clipping the velvety erineal structure with the upper and lower surfaces of the leaves; iii) attaching/clipping the velvety portion with upper and lower surfaces of the leaves with prior laceration by carborandum powder; iv) application of ferric chloride ($FeCl_3$) suspension on upper and lower surface; v) scrapped and subsequently dissolved velvety erineal mass in distilled water sprayed on both upper and lower surfaces and vi) puncturing the upper and lower surfaces of the leaves with the help of entomological pin and then velvety erineal mass was attached.

So for the purpose of this part of experimentation the authors tried in six different ways to produce the *Cephaleuros* sp. induced symptom artificially. Laceration was done with the help of carborandum powder and the velvety part of erineum was fixed with the leaves through stappling. Ferric chloride ($FeCl_3$) suspension was prepared through diluting 1.5 g of the chemical in 100 ml of distilled water. After this operation a periodical observation at 15 days interval was recorded upto 90th days.

Preparation of culture of parasitic algae (C. virescens *Kunze*)

Litchi erineum was collected from the field during rainy season. The velvety erineal mass (light brown and deep brown) on the ventral side and ring spots (rusty brown colour) on the upper side of the leaves, were collected for pure culture preparation. They were cut into small pieces (1 cm square) and washed in 0.1% mercuric chloride solution for 2-3 minutes followed by subsequent washing with distilled water 2-3 times. Afterwards, they were placed in a conical flask (250 ml) containing 125 ml of Bristol's solution (Bristol, 1920) under laminar air flow. The conical flasks were placed on a rack containing 1200 lux illumination for 24 hrs.

Initiation of growth of parasitic alga

After 30 - 35 days of inoculation light greenish coloured frothey mass developed. They were jerked regularly to enhance rapid multiplication. After 60 -72 days a moderate quantity of green coloured flappy mass appeared within the conical flask.

Isolation of pure culture

The basic culture (stock culture) was transferred (0.5 ml, 1 ml, 1.5 ml.) in 3" petri plates

containing a layer of Agarised Bristol's medium (15 g agar dissolved in 1 litre of Bristol's medium). After pouring the requisite quantity of algal suspension on the predescribed agarised Bristol's plate, a layer with only agar solution (15 g agar + 1 litre distilled water) was applied. All the petri plates were covered and placed under illumination for 24 hrs., 4-5 days later, the initiation of growth took place and on the 15th day the petri plates showed the errection of the culture mass through penetrating the covering plain agar base. It indicates the culture coming out through that plate is pure in form. From the petri plates containing first culture, the emerging colonies were counted and different amount of stock culture used were exhibited for different numbers of CFU (Colony Forming Unit).

Cell count

10^3M and 10^4M solution was prepared from pure culture in Bristol's media by mixing. 1 ml of stock culture with 9 ml of distilled water. From this suspension 0.1 ml broth was taken on a hemocytometer (Neubauer, made in GDR, Blankenburg) for cell count under a microscope (x 400 x).

Spraying of algal suspension for the production of Cephaleuros *symptoms on the litchi leaves*

Two stock solutions were prepared at 10^3M and 10^4M. They were sprayed in the litchi twigs containing early flush of leaves. The twigs were sprayed with dicofol @ 1 ml/l 3 days prior to application of algal suspension, to ensure absence of mites. After application of insecticides the twigs were covered with polypropylin bags. Four days after application of insecticide, algal suspension was applied with the help of hand automiser. Spraying was done till the runoff level. Another set of twigs were lebelled for application of algal suspension with prior laceration of both the leaf surfaces with carborendum powder. The laceration was done on the fourth day after treating the twigs with dicofol or just before spraying of algal suspension. The twigs were protected from introducing mites with the help of a popypropylin bags as mentioned earlier.

RESULTS AND DISCUSSION

Incidence of Aceria litchi *Keifer*

It was revealed from the Table 1 and Fig. 1.1 that the effect of interaction between grade and direction on the rate of incidence was significant at 5% level. This showed that proportion of various grades of infested leaves was not distributed in similar fashion in the 4 directions of a plant. It was observed that the maximum percentage of 'A' grade leves was recorded in the western direction (14.50%) followed by northern (13.15%), southern (13.04%) and eastern (11.74%). The different observation among 4 direction were not always statistically significant. Similarly, maximum number of 'B' grades leaves was also found in the western direction (17.67%). But, incase of 'C' graded leaves maximum percentage of infestation was noticed in eastern direction (20.53%) and the minimum infestation was maintained in case of 'D' graded leaves where the percent infestation was high as 24.77 in the eastern direction.

The maximum infestation irrespective of grade was recorded in the eastern direction (18.46%) followed by nothern direction (17.61%) and least infestation in southern direction (16.67%).

The effect of interaction between month and direction was also considered and data obtained have been presented in Table 2 and Fig. 2.1. It may be mentioned that, during May the maximum incidence was recorded in the eastern direction (19.53%) and the minimum in the southern direction (17.56%). The percentage of infestation decreased from the month of October onwards. During this month, in case of eastern direction the percentage was 10.38. Minimum incidence was noticed in all the direction during the month of November. Minimum percentage of infestation was recorded in northern direction (14.07%).

The literature revealed that comprehensive information on seasonal incidence of *Aceria litchi* Keifer. are lacking except for the work of Singh (1986). Most workers have studied the seasonal incidence of the mite based on the percentage of infested leaves. This simple observation has resulted enormous error. The present authors followed the procedure of Singh (1986), where various infested leaves were graded for minimising the error. Similarly 4 directions of a plant should also be given due consideration because the mite disperses by wind. It is well known that the direction of wind varies from day to day as well as from month to month during the various season of a year. It is generally agreed that the abundance of *A. litchii* K. is always associated with the new and intermittent flashes. Lall and Rahman (1975) reported maximum and minimum population during March and December respectively. According to Misra (1912) the incidence first appeared during March and remained till June-July. Similarly Ray and De (1950) claimed that, first incidence of the mite was found during the month of March and it continued its breeding on litchi till October. Singh (1958) on the other hand recorded maximum population of the mite during July. Singh *et al.* (1967) further reported that the initiation of breeding season of the mite was found during March with a miximum biological activity during July. This finding is in confirmity with the findings of the present authors who recorded the maximum percentage of infestation during June-July.

In general, the mite is most prevalent during May - July. Their activity remain a minimum during December to February. This is almost similr to the present findings. Generally, the mite prefers to remain in the North - East direction of a litchi plant. This finding has impact on the population dynamics of the mite.

Studies undertaken on the rate of incidence of litchi mite revealed that highly significant difference in the rate of incidence was recorded among various month, 4 direction and grades. The maximum incidence was in the eastern direction of a plant and the maximum number of infested leaves came under 'D' grade followed by 'C' grade.

Effect of different mechanical treatments to induce erineal structure of young litchi leaves artificially

It has been established by Sharma (1991) that it is possible to produce erineal structure causing leaf curl on litchi leaves with the application of crushed erineal surface on the litchi leaves. The symptoms were produced after 3 months. Due to lack of scientific documents it was felt necessary to investigate the different ways of artificial production of erineal structuer, if any, on the litchi leaves. For this purpose very young litchi leaves (leaves just taking yellowish green colour from the initially coppery colour) were selected and different mechanical treatments, like laceration, puncturing etc. were done. Apart from mechanical treatments, chemical like ferric chloride ($FeCl_3$) as suspension was used.

keeping in view that the alga needs iron for its better development. Stappling of erineal structure also done on both the upper and lower surfaces and with or without puncturing the leaf surface (Table-3).

Table. 1. Effect of interaction between grade and direction of the prevalance of *Aceria litchii* Keifer on litchi plant at mounduri orchard

Infestation grade	Direction of sample leaves			
	Eastern	Western	Northern	Southern
A	4.14 *(11.74)	6.27 (14.50)	5.18 (13.15)	5.09 (13.04)
B	6.13 (14.33)	9.21 (17.67)	8.55 (17.01)	6.46 (14.72)
C	12.30 (20.53)	6.46 (14.72)	9.63 (18.07)	9.18 (17.63)
D	17.56 (24.77)	12.18 (20.43)	13.25 (21.35)	12.18 (20.42)
Mean	10.03 (18.46)	8.53 (16.98)	9.15 (17.61)(16.67)	8.23

* Figures in parenthesis are original values.C. D. (p=0.05) = 0.081

Table. 2. Effect of interaction between month and direction of the prevalance of *Aceria litchii* keifer on litchi plant at mounduri orchard during the period from May to November 1991-1992.

Month	Direction of sample leaves			
	Eastern	Western	Northern	Southern
May	11.18 *(19.53)	9.60 (18.05)	10.18 (18.61)	9.10 (17.56)
June	17.25 (24.54)	15.30 (23.03)	11.13 (19.49)	10.92 (19.30)
July	16.25 (23.77)	10.21 (18.63)	8.15 (16.59)	8.45 (16.90)
August	9.30 (17.75)	5.25 (13.24)	8.18 (16.61)	7.25 (15.62)
Sep.	10.15 (18.58)	3.24 (10.37)	2.15 (8.43)	6.18 (14.39)
Oct.	3.25 (10.38)	4.15 (11.75)	1.13 (6.10)	3.25 (10.38)
Nov.	1.08 (5.95)	0.56 (4.29)	0.47 (3.93)	0.5 (4.05)
mean (Direction)	9.78 (18.22)	6.90 (15.23)	5.91 (14.07)	6.52 (14.79)

C. D. (p=0.05) = 0.096
*Figures in parenthesis are original values.

Table. 3. Effect of different mechanical treatments for the artificial production of erineal structure on litchi leaves

Treatments	Observation for symptoms after different days						
	7th	15th	30th	45th	60th	75th	90th
I. Laceration :							
a) upper surface of leaves	Healing start	Healing	Healing	Healing	Ring on upper surface	Ring on upper surface	Dried
b) Lower surface of leaves	Do	Do	Do	Dried	Dried	Dried	Dried
II. Stappling of symptoms :							
a) Upper surface of leaves	NAD	NAD	NAD	NAD	NAD	NAD	NAD
b) Lower surface of leaves	NAD	NAD	NAD	NAD	NAD	NAD	NAD
III. Laceration & stappling :							
a) Upper surface of leaves	Healing	Healing	Healing	Dried	Dried	Dried	Dried
b) Lower surface of	start	start	start	start	start	start	start
IV. Suspension of $FeCl_3$:							
a) Upper surface of leaves	NAD	NAD	NAD	NAD	NAD	NAD	NAD
b) Lower surface of leaves	NAD	NAD	NAD	NAD	NAD	NAD	NAD
V. Scrapping of erineum from the infested leaves & then dissolved in distill water & then spray the sspension :							
a) Upper surface of leaves	NAD	NAD	NAD	NAD	NAD	NAD	NAD
b) Lower surface of leaves	NAD	NAD	NAD	NAD	NAD	NAD	NAD
VI. Puncture the leaf and then attached the symptom :							
a) Upper surface of leaves.	NAD	NAD	NAD	NAD	NAD	NAD	NAD
b) Lower surface of leaves	NAD	NAD	NAD	NAD	NAD	NAD	NAD

*NAD = Not at all detected

Table. 4. No. of CFU (Colony Forming Unit) developed with different dosages of parasitic algal suspension provided in Agarised Bristol's media

Dosage of algal suspension	No. Of. CFU/Petriplates					
	1	2	3	4	5	6
> 0.5 ml	42	52	25	NC	44	15
> 1.0 ml	102	96	NC	81	51	NC
> 1.5 ml	99	148	NC	132	NC	111

* NC = Not considered for observation.

Table. 5. Colony forming units (CFU) in the culture growing in the laboratory

Observation number	No. of CFu	No. of Cells (109 ml)	CFU ($x10^9$)
1	48	3710	178080
2	7	3550	24850
3	27	3300	89100
4	18	3750	67500
5	25	3110	77750
6	5	3480	17400
7	17	3510	59670
8	14	3420	47880

Table. 6. Number of cells present in culture growing in the laboratory (Cells x 10^3 or 10^4/ml)

Observation Number	No. of Cells (x 10^3/ml)	No. of Cells (x 10^4/ml)
1	4170	3640
2	4480	3540
3	4600	3590
4	4330	3760
5	4380	3610
6	4220	3690
7	4140	3380
8	4430	3470

The observation were taken from the 7th day after the treatment and continued upto 90th day. For close observation, first two readins were recorded at an interval of 7 days. The others were taken at 15 days interval. It was observed, that in case of laceration on the upper surface, healing started and after 2 months a fade ring spot appeared which

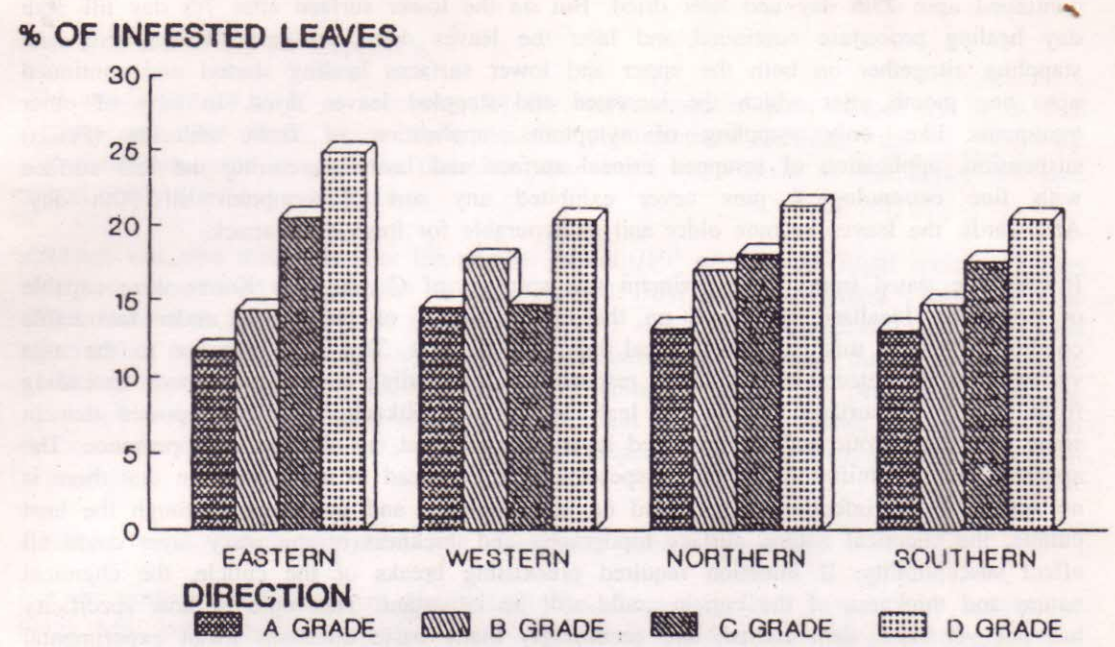

Fig. 1.1. Effect of interaction between grade and direction of the prevalance of *Aceria litchii* Keifer on litchi plant

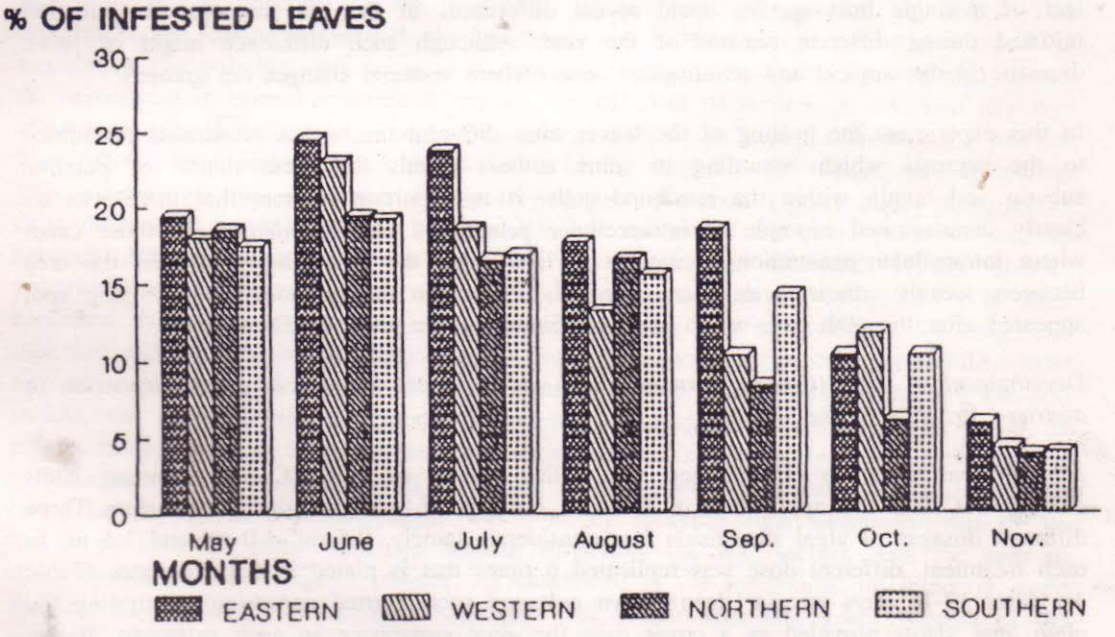

Fig. 2.1 Effect of interaction between month and direction of the prevalance of *Aceria litchii* Keifer on litchi plant

continued upto 75th day and later dried. But on the lower surface after 7th day till 30th day healing procedure continued and later the leaves dried. In case of laceration and stappling altogether on both the upper and lower surfaces healing started and continued upto one month after which the lacerated and stappled leaves dried. In case of other treatments like, only stappling of symptoms, application of ferric chloride ($FeCl_3$) suspension, application of scrapped erineal surface and lastly puncturing the leaf surface with fine entomological pins never exhibited any sort of symptom till 90th day. Afterwards, the leaves become older and unfavourable for fresh algal attack.

It could be stated from this experiment that sprangia of *C. virescens* Kunze were capable of producing localised ring spot on the upper surface of the leaves under favourable conditions but in this case mechanical injury is a must. The host response to the alga varied from no detectable anatomical response in substending tissues to necrosis extending from surface to surface through the leaf. Joubert and Rikenberg (1971) reported that in some host the mitotic activity produced layers of cells that are corklike in appearance. The apparent lack of uniformity among suspeptible host can lead to the suggestion that there is no specificity. If infection is predicted on attachment to and penetration through the host cuticle, the chemical nature, surface topography and thickness of the waxy layer could all effect susceptibility. If infection required preexisting breaks of the cuticle, the chemical nature and thickness of the cuticle could still be important. The topic of host specificity has not yet been well studied, and accordingly many basic questions await experimental investigation. Generally a host plant weakend by lack of nutrients, by a fungal pathogen, or by any numerous other factors would probably evidence a more severe reaction to a *Cephaleuros* infection. The rather broad topic of enviromental factors must be considered for infection. Examination of infection by a single species of *Cephaleuros* restricted to the leaf of a single host species could reveal differences in the host response to infection initiated during different seasons of the year. Although such difference might be more dramatic in the tropical and semitropical areas (where seasonal changes are greater).

In this experiment the healing of the leaves after different mechanical treatments resembled to the necrosis which according to some authors entails the accumulation of putative suberin and tannin within the muribund cells. It is important to note that there was no clearly demonstrated example of intraceellular penetration by *Cephaleuros.* In those cases where intracellular penetration occured it is likely that the alga simply invaded the area between, weakly adhearing dead cells. In this study also on the dorsal surface ring spot appeared after the 60th day, which is in confirmity of the previous discussion.

Development of CFU (Colony Forming Unit) with different dosages of algal suspension in agarised Bristol's media plates

Attempt was made to observe and record the number of CFU (Colony Forming Unit) coming out with the application of different dosages of parasitic algal suspension. Three different dosages of algal suspension was considered namely, 0.5 ml, 1.0 ml and 1.5 ml In each treatment, different dose was replicated 6 times that is plated in 6 petri plates (Table 4). After 17-18 days circular deep brown coloured spots started appearing penetrating the plain agar slanst provided as a cover over the algal suspension in each petriplate. It can be revealed from the table that the maximum number of CFU was encountered with 1.5 ml of algal suspension. The number ranged from 99-148 per petriplate. The minimum CFU

was recorded in 0.5 ml suspension.

The production of CFU is neccessay for the maintenance of pure culture. As it is well known that this algae needs light for its photosynthetic activity, that is why the zoosporangium used to puncture the plain agar sland and remain on the upper side and subsequently start and multiplying.

Attempt was also made to count the number of cells/10^3 ml dilution. Eight such pertiplates were considered and the number of CFU ranged from 5-48/petri plates (Table 5). The CFUs were than transferred and diluted in distilled water and subsequently cell count was taken with the help of haemocytometer. It is interesting to note that the petri plate contining 7 CFU contained 3550 cells/10^3/ml solution, while the petri plate showing maximum number of CFU (48) provided a cell count of 3710. So it can be concluded that the number of cells present in a CFU does not depend on the number of CFU present in a petri plate.

Artificial inoculation for the production of erineum (velvety symptoms)

For the purpose of this part of the investigation, the young litchi leaves were isolated in twigs and were lebelled properly. Algal suspension (cells/10^3/ml and cells/10^4/ml) were considered for inoculation (Table 6). The twings to be applied with algal suspension were previously treated with dicofol to ensure the absence of any mites. After 3rd day of acaricidal application, the algal suspension into 2 different concentrations were applied with the help of a high volume sprayer. The treated twigs were put in a polypropyline cover tied with rubber guarder for the protection of entry of other mites or insets. This experiment was conducted in both the laboratory and field conditions. After one month of inoculation the polypropyline cover was removed randomly from the treated twigs to see the appearence of erineal structure if any on the leaf. But no replication provided any sign of such symptoms production. They were again put back and kept for another 1.5 months. Thus after a total period of 2.5 months none of the treated twigs yielded any symptoms. This experiment was conducted during July-August. Wellman (1972) cited examples of clear differences in susceptibility between different species of the same genus as well as between different varieties of the same species. Marlatt and Campbell (1980) reported statistically different responses to *Cephaleuros* infection in cultivars of guava. It is often explained that broad leaved evergreens provide substrates that are available for long term infection and successive reporductive cycle. but other factors affecting susceptibility must also be involved. If infection is predicted in attachment to and penetration through the host cuticle, the chemical nature, surface topography and thickness of waxy layer would all effects susceptibility. If infection requires existing breaks in the cuticle, the chemical nature and thickness of the cutcile is still important. Attempts were made during investigation to infect healthy leaves artificially. This was done by spraying algal suspension directly on leaves on both the sides with and without scratching the leaf surface with the help of sharp needle and carborandum powder. As mentioned in the foregoings, no infection could be detected on leaves where the inoculation was made. This also leads support ot the contention that algal infection takes place through stomata and the possible role of insects and arachinds as agents of infection can not be ruled out. It is important to note that there is no domonstrated example of intracellular penetration by *Cephaleuros*. In those cases where intracellular penetration occur it is likely that the alga simply invades the area

between weakly adhering dead cells. So from the findings of this part of experimentation it is obvious that on the dorsal side the *Cephaleuros* infection which appeared as ring spot is dependent on the entry of the pathogen through stomatal opening, health of the plant, preexisting cracks etc. But the velvety erineum of *Cephaleuros* infection on the ventral side is purely dependent on the previous puncturing by arachiids specially *Aceria litchii* Keifer through which the opportunist algal pathogen moving in air took entry and exhibit proliferated growth of *Cephaleuros* which is substantiated through the outer most sterile hairs or trichomes.

REFERENCES

Batista, A. C. and Lima, D. A., (1949). Lista de suscetiveis da alga *Cephaleuros mycoidea* Karsten Pernambuco. *Bull. Sec. Agr. Ind. Com.* **16**: 32-46.

Bristol, B. M., (1920). On the alga flora of desiceated English soils : an important factor in soil biology. *Ann. Botany.* **34**: 35-79.

Golato, C., (1970). Una grave malattia dell annacardio (*Anacardium occidentale* L.) in Tanzania. *Riv. Agric. Subtrop.* **64**: 334-340

Holcomb, G. E., (1975). Hosts of the alga *Cephaleuros virescens* in Louisiana. *Ann. Proc. Am. Phytopath. Soc.* **2**;134.

Jeppson, L. R., Keifer, H. H. and Baker, E. W., (1975). Mites Injurious to economic plants. University of California Press, London, pp.614.

Jose, G. and Chowdary, Y. B. K., (1980). New records of *Trentepohlias* from India. *Nova Hedwigia.* **32**: 725-731.

Jubert, J. J. and Rikenberg, F. H. J., (1971). Parasitic green algae. *Ann. Rev. Phytopath.* **9**: 45-64.

Lall, B. S. and Rahman, M. F., (1975). Studies on the bionomics and control of the erinose mite *Eriophyes litchii* Keifer (Acarina : Eriophidae). *Pesticides.* **9**(11): 49-54.

Marlatt, R. B. and Campbell, C. W., (1980). Susceptibility of *Psidium guajava* selections to injury by *Cephaleuros* sp. *Plant Dis.* **64**: 1010-1011.

Misra, S. C., (1912). Litchi leaf curl. Agr. *J. India.* **7**: 286-293.

Premila, N., Nirmala, R. and Bharathan, S., (1990). A preliminary report on the epiphytic and epiphyllous green algae from Nilgiris. *Phykos.* **29** (1 & 2): 159-165.

Ray, S. S. and De, B. N., (1950). Control of litchi mite. *Ind. J. Hort.* **7**(1): 16.

Roth, G., (1971). An algal leafspot disease on avocado pears (*Persea americana* Mill.) in South Africa. *Phytopath. Z.* **70**: 323-334.

Santra, S. C., (1988). Some new records of Indian Trentepohliaceae. *J. Indian. Bot. Soc.* **67**: 65-66.

Saxena, P. N., (1962). Algae of India. 1. Chaetophorales. *Bull.* National Botanic Garden, Lucknow. **57**: pp 1-59.

Sharma, D. D., (1991). Occurrence of *Cephaleuros virescens* Kunze a new record of leaf curl in litchi (*Litchi chinensis*). *Indian J. Agric. Sci.* **61**(6): 446-448.

Singh, R., (1958). The Litchi in India, ICAR, New Delhi, India.

Singh, S., Krishnamurty, R. and Katyal, S. L., (1967). Fruit culture in India, ICAR, New Delhi. India.

Singh, P., (1986). Bionomics of *Aceria litchii* Keifer (Prostigmata : Eriophyidae). Ph. D. Thesis. Deptt. of Agril. Entomology, B.C.K.V., Mohanpur, Nadia, West Bengal, India.

Somchoudhury, A. K., Singh, P. and Mukherjee, A. B., (1989). Interrelationship between *Aceria litchii* Keifer (Acari : Eriophyidae) and *Cephaleuros virescens* a parasitic alga in the formation of erineum like structure on litchi leaf. In : *Progress in Acarology*, Vol. 2, Oxford and IBH Publishing House, New Delhi, pp. 147-152.

Vidyasekaran, P. and Parambaramani, C, (1971 a). Carbon metabolism of alga infected plants *Indian Phytopath* **24** : 369-371

Vidhyasekaran, P. and Parambaramani, C., (1971b). Nitrogen metabolism of alga infected plants. *Indian Phytopath.*, **24**: 500-504.

Wellman, F. L., (1965). Pathogenecity of *Cephaleuros viresces* Kunze in the neotropics. *Phytopathology.*, **55**: 1082.

Welman, F. L., (1972). Tropical American Plant Disease (Neotropical phytopathology problems, **26**: 639-668.

Winston, J. R., (1938). Algal spot of orange. *Phytopathology* **28**: 283-286.

Yadav, A. S., (1953). Some new hosts of *Cephaleuros* from Bihar. *Curr. Sci.* **22**: 28.

Yadav, A. S., (1955). Some new hosts of *Cephaleuros* from Bihar. *Curr. Sci.* **24**: 124.

Yadav, A. S. and Srivastava, J. G., (1957) (Abst.) Some new hosts of *Cephaleuros* from Bihar. Proc. 44th *Indian Sci. Congr.* **32**: 725-731.

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