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VINGNANAM
Journal of Science

Publication of volume 4 (nos. 1 & 2) of Vingnanam has been delayed, once again due to circumstances beyond our control. The saddest among these is the untimely demise of the former Chief Editor S. Kandiah who had served in that capacity since the birth of Vingnanam.

In volume 4 we publish our first article in physics : "Diffusion of Hydrogen in Metals" by K. Kandasamy.

Two papers deal with diseases of local crops: the paper by R. V. S. Sundaresan and Pathmasany Varatharajah with the mosaic disease of papaya and the paper by Jayadevi Kailayapillai, A. Sivapalan and K. Theivendirarajah with the powdery mildew disease of sesame.

G. F. Rajendram with Nirmala R. Antony and Rohini Nagalingam initiate the first study of the mosquito fauna in Jaffna peninsula. Another paper by G. F. Rajendram reports on geographic genetic variation among populations of a green rice leafhopper from India, Sri Lanka and the Philippines.

June 1991 ***Editor***

VINGNANAM Jaffna.

JOURNAL OF SCIENCE

Volume 4 December 1989 Numbers 1 & 2

CONTENTS

DIFFUSION OF HYDROGEN IN METALS

K. KANDASAMY

(Department of Physics, University of Jaffna, Sri Lanka.)

Vingnanam — Journal of Science 4 : 1 — 7 (1989)

ABSTRACT : The Chen Min Li formalism (Chen Min Li 1978) for the flux of mobile solute in a stressed solid is used to derive an equation for diffusion flux of hydrogen in metals. The predictions from this equation are compared with the experimental results reported by Lewis *et al.* (1987). The agreement is satisfactory.

Introduction

Inclusion of Hydrogen into the lattice of many metals causes expansion of their lattice (Kandasamy 1980), which in turn creates an elastic field in the metal lattice. The created elastic field is not limited to the sites of inclusion but is extended over a long range in the metal. The elastic field in a metal which contains hydrogen is capable of inducing diffusion of hydrogen (Gorsky 1935). The diffusion processes in metals, which exhibit lattice expansion on the inclusion of hydrogen, therefore, cannot be governed by Fick's law. Fick's law assumes that the concentration gradient is the only physical parameter which contributes to the diffusion of hydrogen in metals. From thermodynamic principles, Chen Min Li developed an expression for the flux of mobile solutes in a stressed solid (Chen Min Li 1978). Using network model Larche and Cahn (1982) derived an expression for the diffusion flux of hydrogen in metals. It was later amended by the author (Kandasamy 1988). More recently non-Fickian nature of hydrogen diffusion in metals, particularly in palladium based alloys (Pd_{81} Pt_{19}) was experimentaly demonstrated by Lewis and his coworkers (Lewis *et al.* 1987). In this communication an equation for the diffusion flux is obtained from the Chen Min Li expression and this equation is solved using computers to explain the results of Lewis and his coworkers (1987).

Theory

In a solid with inhomogeneous distribution of hydrogen the hydrogen diffusion is not only governed by the concentration gradient but also by the gradient of the stress which is induced by the inclusion of hydrogen into the metal. According to Chen Min Li (1978) the diffusion flux of hydrogen

in the x direction, Jx, when a metal membrane, which initially contained a uniform distribution of hydrogen concentration, Co, absorbs further hydrogen into one of its faces parallel to the YZ plane, is given by

$$Jx = -D\frac{dc}{dx} + \frac{Co\ \bar{V}_H\ D}{R\ T}\ \frac{d\sigma}{dx} \qquad (1)$$

where D is the diffusion coefficient of hydrogen in the metal, $\bar{V}_H$ is the partial molar volume of hydrogen in the metal, $\frac{dc}{dx}$ is the concentration gradient $\frac{d\sigma}{dx}$ is the stress gradient and the other symbols have their usual meaning. The induced stress ó depends on the geometry of the metal sample in addition to the nature of the inhomogeneity of the hydrogen distribution. We shall consider a thin slab sample of thickness L (Fig. 1) containing a uniform distribution of hydrogen of concentration Co. If one of its faces, say the face at X=O and parallel to the YZ plane, is exposed to a high concentration Cs of hydrogen, then the sample absorbs more hydrogen. The absorption of hydrogen disturbs the initial uniform distribution of hydrogen and induces stress in the metal lattice.

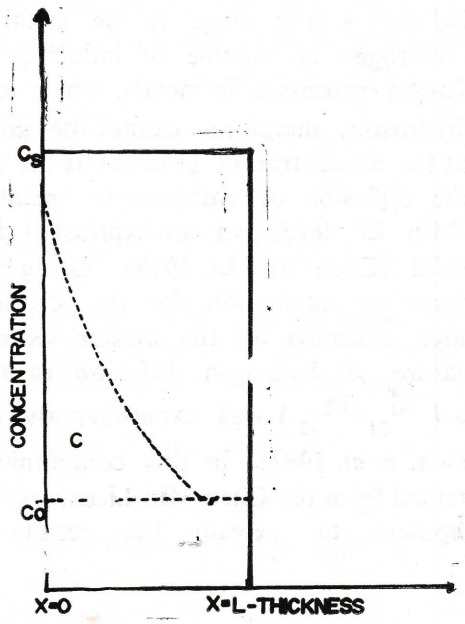


Fig. 1: Variation of hydrogen concentration (C) along the thickness of a thin slab (thickness of slab=L). Co is the initial concentration (distributed uniformly) of hydrogen in the slab. Cs is the concentration of the hydrogen atmosphere into which the absorbing face (face at X=O) of the slab is exposed.

The new distribution of hydrogen concentration is represented by

$$\frac{C - Cs}{Cs - Co} = 1 - 2\Sigma_{n=o} (-1)^n / p_n \exp\left[\frac{(-\rho^2)Dt}{L^2}\right] \text{Cos } p_n \left[\frac{X}{L} - 1\right]$$

$$= \frac{\Delta C}{\Delta Cs} \text{ (say),}$$

where $p_n = (2n+1)\pi/2$ (2)

The three components of induced stress are given by

$$\sigma_{xx} = 0$$

$$\sigma_{yy} = \sigma_{zz}$$

$$\sigma_{yy} = -\frac{-V_H E}{3(1-v)} \left\{ \Delta C - \frac{1}{L}\int_0^L \Delta C\, dx - \frac{12}{L^3}\left\{X - \frac{L}{2}\right\} \int_0^L \Delta C \left\{X - \frac{L}{2}\right\} dx \right\} \quad (3)$$

where E is the Young's modulus, and v is the Poisson's ratio of the sample and ΔC is the change in hydrogen concentration due to absorption. The above equation is obtained from the Chen Min Li's equation with the imposition of boundary conditions used in this study.

On substitution for $\frac{d\sigma}{dx}$ in equation (1) for the flux of hydrogen, we will get

$$Jx = -\left\{1 + \frac{2Co\bar{V}^2_H E}{3(1-v)RT}\right\} D\frac{dc}{dx} + \frac{8Co\, E\, \bar{V}^2_H D}{(1-v)\, R\, T\, L^3}\int_0^L \Delta C\left[X - \frac{L}{2}\right] dx \quad (4)$$

The form of the above equation is similar to the amended equation of Larche and Cahm (Kandasamy 1988). The first term in the equation represents the modification in the effect of concentration gradient in diffusion due to the presence of hydrogen in the metal lattice. The second term represents the effect of induced stress due to the inclusion of hydrogen in the metal lattice.

Results and Discussion

We shall consider an experimental situation like the one conducted by Lewis *et al.* (1987) in which the hydrogen atoms diffusing through a tube having a thin wall of thickness L and area A are collected in a volume V. For this case, the pressure change P, inside the volume is given by

$$P = \frac{RTA}{V} \int J_{x=L} \, dt \quad (5)$$

The thickness of the tube wall is very small compared to the diameter of the tube, and therefore it can be considered as a thin slab.

The flux diffusing out of the slab is $J_{X=L}$ which is given by

$$J_{x=L} = - \left\{ 1 + \frac{2\ Co\ \bar{V}^2_H E}{3(1-\nu)\ RT} \right\} D \left.\frac{dc}{dx}\right|_{X \to L} - \frac{8\ \bar{V}^2_H ED\ Co\ \triangle Cs B}{(1-\nu)\ RTL} \quad (6)$$

Where

$$B = \sum_{n=o}^{n} \frac{(-1)}{p^3} \left\{ p_n \sin p_n + 2 - 2 \cos p_n \right\} \exp \left\{ \frac{-p^2_n\ Dt}{L^2} \right\} \quad (7)$$

For metals like palladium $\bar{V}_H = 1.65 \times 10^{-6} m^3$ mole^{-1} $\frac{E}{1-\nu} = 10^{11}$ Nm^{-2} and $C = 10^5 n$. where n is the hydrogen atoms to metal atoms ratio. At room temperature $RT = 5 \times 10^3$ J mole^{-1} On substituting these data

We obtain

$$J_{x=L} = - \left\{ 1 + \frac{20\ no}{3} \right\} D \left.\frac{dc}{dx}\right|_{X \to L} - 8 \times 10^6\ no\ \frac{\triangle ns}{L} D\ B \quad (8)$$

where $Co = 10^5$ no and $Cs = 10^5$ ns

Using the above relationship for $J_{X=L}$ and L = 0·25 mm, the pressure change P was computed for different initial conditions. The results are shown in Fig. 2. The computed variation of P in each case is in agreement with the results of Lewis *et al.* (1987). For easy comparison, their results are reproduced in Fig. 3.

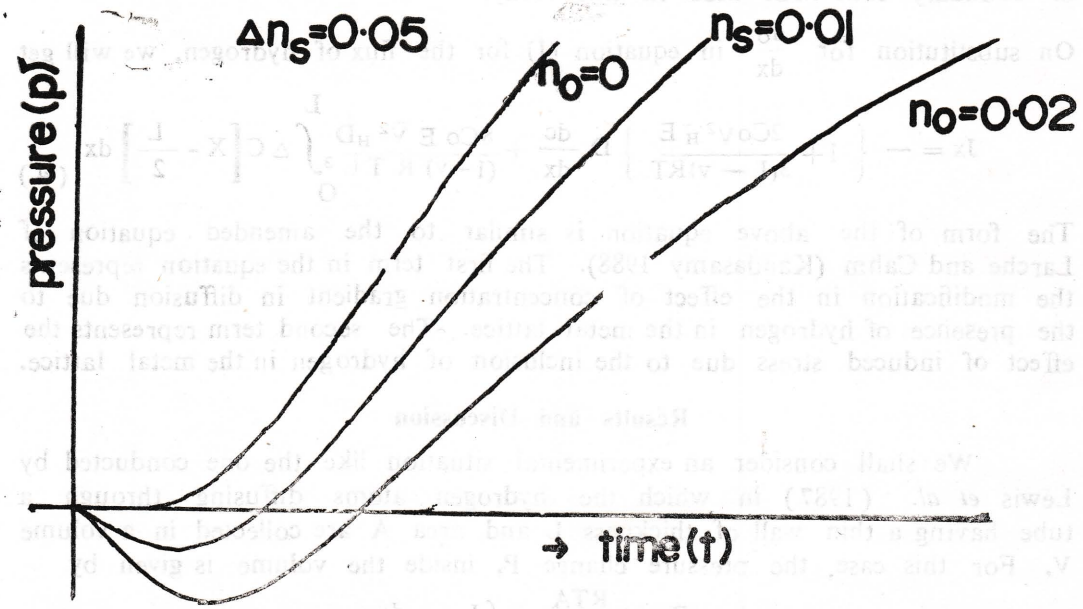
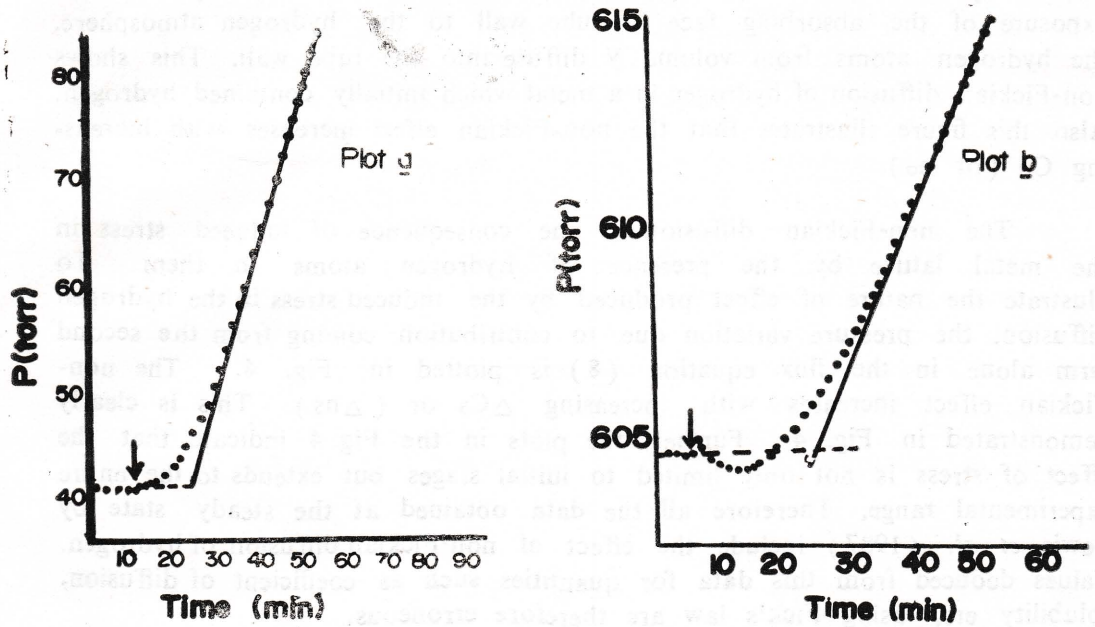


Fig. 2: Variation with time (t) of the pressure (P) inside the volume V (into which the diffused hydrogen atoms are being collected) computed using equation (8) with △ns = 0.05 and different values for no



Plot: a Hydrogen pressure in the tube as a function of time. Initial conditions: membrane equilibrated from both sides with a hydrogen pressure of 40 Torr; pressure increase in the bulb (indicated by arrow) to 625 Torr; temperature, 26±9·2° C; breakthrough time, 12·5 min.

Plot: b Hydrogen pressure in the tube as a function of time. Initial conditions: membrane equilibrated from both sides with hydrogen pressure of 605 Torr; pressure increase in the bulb (indicated by arrow) to 815 Torr; temperature, 26±0·2° C; breakthrough time, 19·3 min.

Fig. 3 : Experimental pressure (P) variation inside the volume V (into which the diffused hydrogen atoms are being collected) with time (t). (Lewis *et al.* 1987)

The line 1 in Fig. 2 shows the variation of P inside the volume V when the absorbing surface of the tube, which has no initial hydrogen, is exposed to a hydrogen atmosphere corresponding to $n_s = 0.05$. As has been expected the variation of pressure reflects the FICKIAN nature of hydrogen diffusion. Lines 2 and 3 in the same figure show the variation of pressure in the volume V when the absorbing surface of the same tube, but with an initial non zero uniform hydrogen concentration, is exposed to the hydrogen atmosphere of same pressure difference. For lines 2 and 3 the initial hydrogen concentration in the tube wall corresponds to $n_o = 0.01$ and 0.02

respectively. The initial drop in pressure indicates that immediately after the exposure of the absorbing face of tube wall to the hydrogen atmosphere, the hydrogen atoms from volume V diffuse into the tube wall. This shows non-Fickian diffusion of hydrogen in a metal which initially contained hydrogen. Also this figure illustrates that the non-Fickian effect increases with increasing Co (or n_o).

The non-Fickian diffusion is the consequence of induced stress in the metal lattice by the presence of hydrogen atoms in them. To illustrate the nature of effect produced by the induced stress in the hydrogen diffusion, the pressure variation due to contribution coming from the second term alone in the flux equation (8) is plotted in Fig. 4. The non-Fickian effect increases with increasing $\triangle Cs$ or ($\triangle ns$). This is clearly demonstrated in Fig. 4. Further, the plots in the Fig. 4 indicate that the effect of stress is not only limited to initial stages but extends to the entire experimental range. Therefore all the data obtained at the steady state by Lewis *et al.* (1987) include the effect of non-Fickian diffusion of hydrogen. Values deduced from this data for quantities such as coefficient of diffusion, solubility etc, using Fick's law are therefore erroneous.

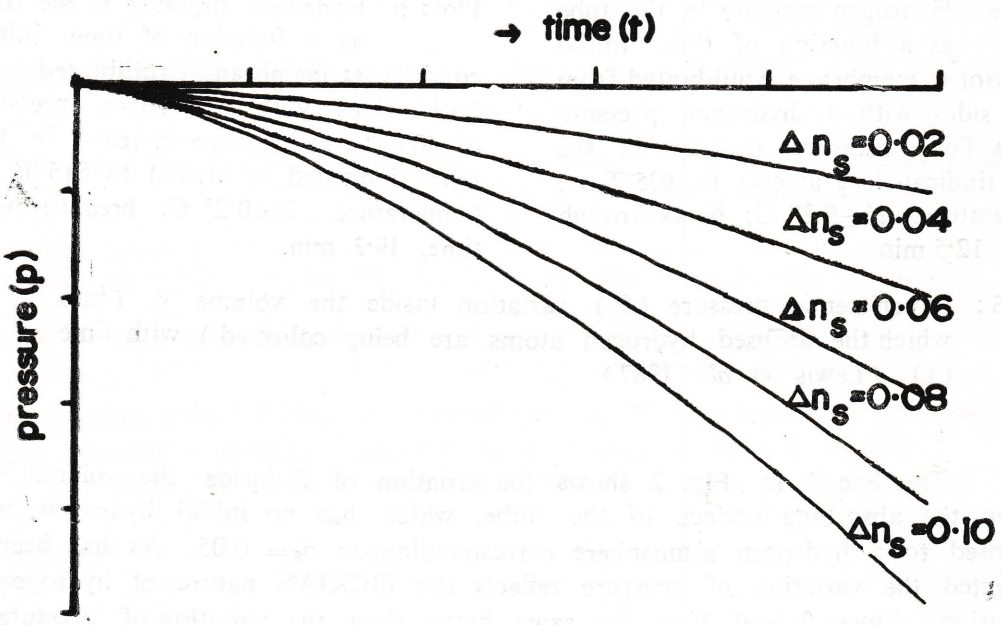


Fig. 4 : Variation with time (t) of the pressure (P) inside the volume V (into which the diffused hydrogen atoms are being collected) computed using only the second term of equation (8) with different values for Δn_s

Conclusion

This study gives a simple theoretical analysis of the data obtained by Lewis and his coworkers in their experiment on diffusion of hydrogen in palladium alloy (Pd_{81} Pt_{19}). The study shows that non-Fickian effect is important and is proportional to the initial concentration of the hydrogen, Co and excess of hydrogen concentration in the absorbing face, ΔCs. Because of the non - Fickian nature of diffusion, all values derived for physical quantities using Fickian diffusion theory are incorrect.

Acknowledgement

My thanks are due to Dr. F. A. Lewis, Queen's University, Belfast, Northern Ireland, for his valuable advice and to Mr. S. Kannan, Computer Unit, University of Jaffna, Sri Lanka, for assistance in computing.

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A STUDY OF THE FREE AMINO ACIDS PRESENT IN THE LEAVES OF PAPAYA (*CARICA PAPAYA* L.) VARIETIES INFECTED WITH PAPAYA MOSAIC DISEASE

R. V. S. SUNDARESAN & PATHMASANY VARATHARAJAH[1]

(Department of Botany, University of Jaffna, Sri Lanka)

Vingnanam — Journal of Science 4 : 8 — 13 (1989)

ABSTRACT : The free amino acids present in leaves of *Carica papaya* L. C. V. Coimbatore 2, CP 124, Local, Solo Hawaii and unknown Indian, both healthy and affected by the papaya mosaic disease were determined by two dimensional paper chromatography, after subjecting the leaf extracts to ion exchange chromatography. The amino acids alanine α — amino butyric acid, arginine, aspartic acid, cysteic acid, glutamic acid, glycine, histidine, isoleucine, leucine, lysine, methionine, phenyl alanine, serine, threonine, tyrosine and valine were identified from the healthy and infected leaf extracts, but in varying concentrations in different varieties. An attempt is made to rationalise the absence of amino acids in some of the healthy and infected varieties and the variation in their concentrations.

Introduction

Viral infection of plants results in the protein and nucleic acid synthesizing machinery of the host cells being taken over by the virus. As a consequence, the protein capsid and the nucleic acid of the virus are synthesized in preference to the proteins and nucleic acids of the host. In addition other proteins as specified by the host and which are involved in inducing resistance against the particular virus too may be synthesized (Kimmins, 1969). The amino acids which are constituents of these two classes of proteins will be in great demand and are likely to be synthesized in significant quantities in the cell. Thus it was decided to investigate whether there were any differences in the composition and concentration of amino acids from leaf extracts of papaya plants systemically infected with papaya mosaic disease compared with healthy plants. This was carried out in five varieties of papaya particularly to relate any possible differences in concentrations of amino acids to differences in susceptibility to the virus.

1 Present address : *School of Agriculture, Kundasale, Sri Lanka.*

Previous investigations undertaken with the same virus–host system had been carried out only in the variety Solo Hawaii and had revealed only the presence of eight amino acids, both in the healthy and infected leaves (Rajapakse, 1981). This observation also prompted the present investigation in order to obtain a more thorough and true picture of the amino acid composition in viral infection.

It has been recently reported that the causative organism of papaya mosaic disease resembles in many aspects the papaya ring spot virus (PRSV) and is suspected to be a strain of this virus (N. Shivanathan : personal communication).

Materials and Methods

Varieties of Papaya under study

Five Papaya (*Carica papaya* L.) varieties were selected for this study. These are C. V. Coimbatore 2, CP124, Local, Solo Hawaii and an unknown Indian variety. Healthy Seeds of four of the varieties were obtained from the Central Agricultural Research Institute, Gannoruwa, and the local variety seeds were obtained from a farmer in Jaffna. Seedlings were raised in polythene bags. Five replicates of each variety were maintained and the experiment was laid out according to the completely randomized design.

Source of virus and inoculation procedure

Virus Virus infected Solo Hawaii leaves obtained from Kandy district were used to inoculate all five varieties of papaya plants.

Preparation of inoculum. One gram portions of infected leaves, after deribbing, were thoroughly ground in phosphate buffer in a sterile mortar. The extract was filtered through a piece of muslin cloth and the filtrate made up to 10 ml with phosphate buffer. A pinch of Carborundum was mixed thoroughly with the filtrate as an abrasive.

Inoculation of plants. Replicate plants were kept in a dark chamber 24 hours before inoculation. The following afternoon the plants were removed from the chamber and the first pair of leaves were inoculated by rubbing the inoculum on the first upper surface with the forefinger. The inoculated leaves were rinsed with distilled water, three minutes after inoculation, to remove the abrasive remaining on the leaf surface. Controls were also maintained. All the plants were maintained in the insect proof glass-house.

Amino Acid Analysis

Preparation of the plant extract. The preparation of the plant extract and subsequent ion exchange chromatography of amino acids was done according to Jeyaratnam (1986). Ten grams of fresh leaves of both healthy and infected plants, two weeks after inoculation, were separately ground in a

blender with 50 ml of 90% ethanol. This homogenate was centrifuged at 10 × 1000 r.p.m. for 30 min. The pellet was discarded and the supernatant evaporated to dryness in a crucible. The residue was dissolved in 25 ml of distilled water and recentrifuged at a speed of 10 x 1000 r.p.m. for 30 min. The supernatant which contained free amino acids and other water soluble compounds was passed through an ion exchange resin column.

Preparation of ion exchange column and collection of free amino acids. A glass column of 1 cm diameter was packed with washed cation exchange resin (Dowex 50) to a height of 20 cm. Before use the resin column was converted to the H^+ form by passing 25 ml of 2N HCl through it followed by distilled water to wash away the unabsorbed chloride ions. The excess acid and the unabsorbed chloride ions were washed with distilled water until the washings were free of chloride ions.

The aqueous plant extract was then allowed to run slowly through this column. The flow rate was regulated to bring about efficient absorption of the amino acids. This was followed by washing of the column with distilled water. The absorbed amino acids were then eluted with 25 ml of 3N NH_4OH. Again 15 ml of 3N NH_4OH was added to elute the remaining amino aeids. The eluate was collected in a clean glass beaker and evaporated to dryness. The residue was disolved in 2.5 ml distilled water and this solution contained the free amino acids. Aliquots of this were used for two dimensional paper chromatography.

Separation of amino acids by paper chromatography. Descending two dimensional paper chromatography was carried out using Whatman no 1 chromatography paper, as described by Elvidge and Sammes (1966) : 10 μl aliquots of the extracts were spotted and the paper was developed with Butan – 1 – ol : acetic acid : water (4 : 1 : 1 ratio) in the first direction and with phenol : water : NH_3 (3 : 1 : 1) in the second direction. Each solvent was allowed to run for 6 hours and then the chromatogram air dried. Amino acids were located by spraying with 0.5% ninhydrin in butan – 1 – ol and warmed in the oven at 85°F. The amino acids were later identified by comparison with a standard chromatogram and the concentration determined by visual observation This procedure was repeated thrice for both healthy and infected leaves of each variety.

Results and Discussion

Chromatograms of healthy and infected leaf of the five varieties of papaya have revealed the presence of 17 amino acids, which are alanine, α – amino butyric acid, arginine, aspartic acid, cysteic acid, glutamic acid, glycine, histidine, isoleucine, leucine, lysine, methionine, phenyl alanine, serine, threonine, tyrosine and valine. However, previous work done with the same virus – host system had revealed the presence of only eight amino acids both in the healthy and infected leaf extracts (Rajapakse, 1981). They were aspartic acid, asparagine, alanine, α – amino butyric acid, cysteic acid, glutamic acid, leucine and valine. Out of these eight amino acids the amide asparagine was not detected in any of the chromatograms in the present study.

The relative concentrations of the amino acid spots in the five varieties of both healthy and infected leaves are outlined in Table 1. Arginine was not detected either in healthy or infected leaves of the varieties Coimbatore – 2 and Solo Hawaii and in the infected leaves of the varieties CP 124 and local variety.

Table 1. Free amino acids and their relative concentrations in leaves of different Papaya varieties

Amino acid	Coimbatore - 2		CP 124		Local		Solo Hawaii		Unknown Indian	
	Healthy	Infec.	Healthy	Infec.	Healthy	Infec.	Healthy	nfec.	Healthy	Infec.
1) Alanine	M	M	W	S	S	M	M	S	S	M
2) ∝-amino butyric acid	T	T	M	M	M	M	W	M	S	S
3) Arginine	—	—	M	—	M	W	—	—	S	S
4) Aspartic acid	T	T	W	T	W	W	W	T	M	N
5) Cysteic acid	T	T	W	T	—	T	W	T	W	T
6) Glutamic acid	S	S	S	S	S	S	S	W	S	M
7) Glycine	M	M	M	M	M	M	S	M	S	M
8) Histidine	—	T	T	T	M	—	W	T	W	W
9) Isoleucine	M	S	W	S	T	T	W	T	M	M
10) Leucine	M	S	W	S	T	T	W	T	M	M
11) Lysine	—	T	T	T	M	T	W	T	W.	T
12) Methionine	M	S	S	S	S	S	S	S	S	S
13) Phenyl alanine	M	S	W	S	T	T	W	T	M	M
14) Serine	W	W	S	S	S	S	S	S	S	S
15) Threonine	S	S	M	M	M	M	W	M	M	M
16) Tyrosine	T	T	T	T	—	M	T	T	W	W
17) Valine	T	T	S	S	S	S	S	S	S	S

Scoring scale : S — Strong, M — Moderate, W — Weak, T – Trace

The absence of this amino acid in Coimbatore –2 and Solo Hawali may be a varietal character, whereas its absence in the infected leaves of CP 124 and local variety too, may indicate the relatively less important role arginine plays in the synthesis of the capsid.

The concentrations of cysteic acid and lysine are less in infected leaves of all five varieties compared with the corresponding healthy leaves. This agrees with the observations made by Rajapakse (1981). The reduction in the concentrations of different amino acids in only the infected leaves of different varieties may be due to the heavy demand of these amino acids for the synthesis of the capsid.

In the variey Coimbatore– 2, histidine, isoleucine, leucine, lysine, methionine and phenyl alanine were present in higher concentrations in the infected leaves than in healthy leaves. It is possible that new proteins may be synthesized from these amino acids in infected plants which may be present as a factor in resisting or tolerating virus infection (Kimmins, 1969) Observations indicate that the presence of high concentrations of amino acids is associated with low infectivity of the causative virus (Varatharajah, 1989). On the other hand there was a reduction in the concentration of six amino acids in the infected leaves of the variety Solo Hawaii, four in the infected unknown variety, three in the infected local variety and one in the infected CP 124 compared with the corresponding healthy leaves. It is possible that the reduction in concentration of many amino acids in the infected leaves of the above varieties may point to a higher incidence of infection and greater susceptibility of these papya varieties to mosaic disease.

Acknowledgement

This study forms part of the M. Sc. thesis of the junior author who was granted study leave by the School of Agriculture, Kundasale.

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BIOLOGY OF PERIDOMESTIC MOSQUITO SPECIES OF JAFFNA PENINSULA

G. F. RAJENDRAM, NIRMALA R. ANTONY AND ROHINI NAGALINGAM

(Department of Zoology, University of Jaffna, Sri Lanka)

Vingnanam — Journal of Science 4: 14—19 (1989)

ABSTRACT: The biology of three peridomestic mosquito species from Jaffna peninsula was studied: *Aedes aegypti* Linnaeus, *Armigeres durhami* Edwards and *Culex quinquefasciatus* Say. The average durations of various developmental stages of *A. aegypti* were: egg 1·69 days, larva 4·5 days and pupa 6·7 days. The total developmental period was 12·9 days. The average durations of the developmental stages of *A. durhami* were: egg 3·12 days, larva 6·84 days and pupa 4·04 days. The total developmental period was 14·0 days. The average durations of of the immature stages of *C. quinquefasciatus* were: egg 5·6 days, larva 5·8 days and pupa 2·9 days. The total developmental period was 14·3 days. The developmental periods of these species appear to be temperature dependent.

Interoduction

Studies on mosquitoes of Sri Lanka, including the recent Southeast Asia Mosquito Project and Medical Entomology project of the Smithsonian Institute, Washington D. C., have been confined to the southern and central regions of Sri Lanka (Green 1901, Carter 1950, Krombein 1981, Amerasinghe 1982). Studies on mosquitoes in northern Jaffna peninsula include a recent survey of peridomestic mosquito species (Rajendram and Antony 1986) and mosquito oviposition in bamboo traps (Antony and Rajendram 1987). The present paper describes the biology of three peridomestic mosquito species of Jaffna peninsula — *Aedes aegypti* Linnaeus, *Armigeres durhami* Edwards and *Culex quinquefasciatus* Say.

Materials and Methods

Live mosquitoes of the three species were collected in individual glass vials and sorted out under a dissecting microscope. They were transferred to plastic sleeve cages 30×25×25 cm, covered with fine nylon mesh at the sides and with a plastic door in front and a cloth sleeve fitted on one side. A

plastic container 7.5 cm diameter and 10 cm high with a rice plant was placed in the cage as well as a 200 ml beaker half filled with water. Observations were made daily. After the eggs hatched into larvae, powdered maldive fish, at the rate of 12 gm/litre, was added daily as food.

The temperature in the laboratory registered a range of 26-32° C and relative humidity 40 to 92%.

Results

The total developmental period of *A. aegypti* from egg to adult stage averaged 12.9 days; the egg stage averaged 1.69 days; the larval stage 4.5 days; and the pupal stage 6.7 days (Table 1).

Table 1: Developmental period of *A. aegypti*

Stage	No. of days	No. of eggs	Average duration in days
Egg	1	23	
	2	26	
	3	6	1·69±0·66
Larva	3	20	
	4	10	
	5	10	
	6	7	
	7	8	4.5 ±1·46
Pupa	3	2	
	4	18	
	5	3	
	7	10	
	9	18	
	11	4	6·7 ± 1·5

Total developmental period = 12·9 ± 3·62 days

The total developmental period of *A. durhami* from egg to adult stage averaged 14.0 days: the egg stage averaged 3.12 days; the larval stage 6.84 days; and the pupal stage 4.04 days (Table 2).

Table 2: Developmental period of *A durhami*

Stage	No. of days	No. of eggs	Average duration in days
Egg	2	7	
	3	8	
	4	10	3·12±0·83
Larva	5	3	
	6	10	
	8	12	6·84±1·18
Pupa	1	3	
	3	6	
	4	8	
	6	8	4·04 ± 1·65

Total developmental period = 14.0 ± 2·66 days

The number of eggs per raft, laid in the laboratory, by *C quinquefasciatus* averaged 112.8 (Table 3).

Table 3: Frequency distribution of number of eggs per raft among 12 unfragmented egg-rafts of *C. quinquefasciatus*

No. of eggs	No. of rafts	Average no. of eggs per raft
80 — 89	01	
90 — 99	01	
100 - 109	02	
110 — 119	04	
120 — 129	02	
130 — 139	02	112·8±13·7

The total developmental period of *C. quinquefasciatus* from egg to adult stage averaged 14.3 days; the egg stage averaged 5.6 days; the larval stage 5.8 days; and the pupal stage 2.9 days (Table 4).

Table 4 : Frequency distribution of minimum duration of various stages of 12 egg rafts *C. quinquefasciatus*

Stage	No. of days	No. of rafts	Average duration in days
Egg	2	2	
	3	4	
	4	1	
	7	2	
	8	1	
	12	1	
	13	1	5·6±1·9
Larva	3	2	
	4	3	
	6	1	
	7	2	
	8	4	5·8±2·1
Pupa	1	1	
	2	3	
	3	4	
	4	4	2·9±0·9

Total developmental period = 14·3±3·8 days

Discussion

The total developmental period of *A. aegypti* in the present study was 12.9 days, with the larval stage at 4.5 days. Francis (1907) reported that the minimum period of larval development of *A. aegypti* at a constant temperature of 27° C was 7 days. Mitchel (1907) reported a duration of 8–13 days in fairly warm weather.

Studies on the biology of *Culex pipiens fatigans* Weid. (*C. quinquefasciatus*) in Sri Lanka were carried out by Chow and Thevasagayam (1957). They reported that the duration of the period between egg and adult averaged 9.7 days; the egg stage was 1-2 days (average 1.35 days); the larval stage, 4–9 days (average 6.45 days); and the pupal stage, 1–4 days (average 1.9 days). They obtained similar results with egg-rafts kept in water obtained from catch pits instead of water obtained from a well. In Calcutta, Roy (1946) reported the period between egg and adult of *C. quinquefasciatus* was 8–10 days during January, 54° F minimum and 81° F maximum (12.2–27.2° C). Pomeroy (1920) reported, without mentioning the temperature, that the minimum duration of the egg stage was 24 hours, of the larval stage, 120 hours, and of the pupal stage, 48 hours.

The developmental period of the three species are related to the laboratory conditions of temperature 26-32° C.

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STARCH GEL ELECTROPHORESIS OF ENZYMES OF *NEPHOTETTIX VIRESCENS* (HOMOPTERA : CICADELLIDAE) POPULATIONS FROM INDIA, SRI LANKA AND THE PHILIPPINES

G. F. RAJENDRAM [1]

(School of Pure & Applied Biology, University of Wales, Cardiff CF1 3TL, United Kingdom)

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ABSTRACT : The banding patterns of eight soluble enzymes, esterase (EST), glucose-6-phosphate dehydrogenase (G-6-PDH), hexokinase (HK), isocitrate dehydrogenase (IDH), lactate dehydrogenase (LDH), malate dehydrogenase (MDH), malic enzyme (ME) and phosphoglucomutase (PGM), were studied in *Nephotettix virescens* (Distant) populations collected from India, Sri Lanka and the Philippines and maintained in glass-houses, on rice variety TN1, at University of Wales, Cardiff, United Kingdom. Adult insects of both sexes were analyzed, using starch gel electrophoresis, and the gel stained for the eight enzymes. The bands in seven enzymes agreed in number and relative mobility in the three populations. In esterase, though three zones of activity were observed in all three populations, the relative mobilities of two bands in the Philippines population differed from *N. virescens* of India and Sri Lanka and could be used for diagnostic separation of the Philippines population. Esterase - 1 bands appear to be sex-related since they were more intense in the females. The results agree with previously reported divergence in the acoustical behaviour of *N. virescens* from Sri Lanka and the Philippines, inducing partial reproductive isolation between these populations.

Introduction

Differentiation between and within species of insects, including agricultural pests, has been made possible by electrophoretic analysis of enzymes (Berlocher 1979, Powell *et al.* 1980. Ayala 1983). One such group of insects studied are the green leafhoppers, *Nephotettix* species, which are common pests of the rice crop in Southeast Asia, Australia and the Pacific Islands (Inoue 1986). These insects have grown in importance as major pests of rice due to their ability to transmit virus diseases (Kalode 1983). Genetic differences between

1 Present Address : *Department of Zoology, University of Jaffna, Sri Lanka*

Nephotettix species have been studied using starch-gel electrophoresis. Ozaki (1969) reported on esterase variation in relation to organophosphate resistance in *Nephotettix cincticeps* (Uhler). Rajendram (1987) reported on genetic variation in a *Nephotettix nigropictus* (Stal) population from Australia. The present paper reports on geographic genetic variation between *Nephotettix virescens* (Distant) populations from India, the source of native cultivars of rice varieties resistant to various pests (Khush 1979), Sri Lanka, an adjacent island country, also a similar source of resistance, and the Philippines, a distant country, devoid of native cultivars of rice with resistant genes.

Meterials and Methods

N. virescens was collected from rice fields in Cuttack, India, Kandy, Sri Lanka and Los Banos, Philippines and maintained on rice variety TN–1, in temperature controlled glass-houses at University of Wales, Cardiff, United Kingdom. *N virecens* was identified according to the characters of the vertex, the nature of the submarginal and marginal black bands on the vertex and the black marking of the anterior of the pronotum, and the genitalia of the 4th instar nymphs (Ghauri 1971).

Electrophoretic analysis was carried out on a total of 80 adults, 40 males and 40 females, from each population for each enzyme system. Individuals from the different populations were run on the same gel to show that any mobility differences were not due to inconsistencies between individual gels. Starch gel was prepared using 11.25% Connaught hydrolyzed starch (lot no. 425–1) in a tris-borate EDTA (ethylenediaminetetra-acetic acid) buffer (pH 8·6). Details of sample preparation and electrophoretic technique are given by Rajendram (1987). An insert dipped in 1% solution of buffered (pH. 8.6) bromophenol blue served as a reference for calculating isozyme migration distance. The bromophenol blue migrated approximately 13 cm during running of the gel, which lasted 5 hours. After electrophoresis, the gel was sliced horizontally and the slices stained for the following enzymes: esterase (EST) (E.C.3.1.1), glucose-6-phosphate dehydrogenase (G–6–PDH), (E.C.1.1.1.49), hexokinase (HK) (E.C.2,7.1.1.), isocitrate dehydrogenase (IDH) E.C.1.1.1.42), lactate dehydrogenase (LDH) (E.C.1.1.27), malate dehydrogenase (MDH) (E.C.1.1.1.37), malic enzyme (ME) (E.C.1.1.40) and phosphoglucomutase (PGM) (E.C.2.7.5.1) according to the methods described by Shaw & Prasad (1970). Among the enzyme systems studied, the fastest band, the most anodal, was assigned a mobility of 1.0, and the other bands were assigned relative mobilities when compared to the distance travelled by the standard band. The slowest band was the most cathodal. In each enzyme system, the bands were numbered 1, 2 or 3 in order of decreasing relative mobility.

Results

Esterase

In esterase, three zones of activity were present in all three populations of *N. virescens* (Fig. 1). Est-1 comprised three weakly staining bands with very close mobilities. They were present, with virtually identical relative mobilities, at 1.0, 0.97 and 0.94, in the males and females of all three populations. These appear to represent a polymorphic locus with three alleles, apparently monomeric in structure. But the bands were insufficiently stained for reliable scoring. All three bands in Est-1 stained more intensely in the females than in the males. Est–2 comprised only one rather intensely staining band and was found in both males and females with relative mobilities of 0.38 in India and Sri Lanka populations and 0.29 in the Philippines population. Est-3 comprised a band with equal intensity with a relative mobility of 0.20 in the India and Sri Lanka populations and 0·13 in the Philippines population.

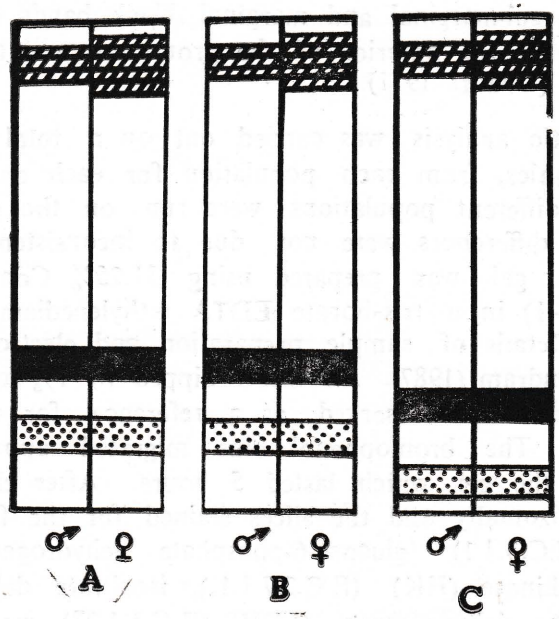

Fig. 1 Zymograms of esterase (EST) patterns in *N. virescens* populations from (A) India, (B) Sri Lanka and (C) the Philippines.

Glucose-6-phosphate dehydrogenase (G-6-PDH)

Two monomorphic bands were seen at relative mobilities of 0.20 and 0.14, identical in all three populations.

Hexokinase (HK)

One zone of activity was present, with an apparently monomorphic band, with a relative mobility of 0.47 in all three populations.

Isocitric dehydrogenase (IDH)

Only one zone of activity was observed. The males possessed a fast electromorph, a single, sharp, well resolved band, with a relative mobility of 0.20 and the females a slightly slower and more diffuse band with a relative mobility of 0.14. The relative mobilities were virtually identical among males and females in each of the three populations.

Lactate dehydrogenasse (LDH)

Two bands were present at relative mobilities of 0.43 and 0.30. These were apparently monomorphic and of identical mobilities in all three populations of *N. virescens* from India, Sri Lanka and the Philippines.

Malate dehydrogenase (MDH)

MDH showed two bands with very similar mobilities and no apparent variation among the individuals. The bands were of identical mobilities, 0.45 and 0.41, in all three populations.

Malic enzyme (ME)

Two slow moving bands were seen at relative mobilities of 0.20 and 0.16 Both were monomorphic with identical relative mobilities in all three *N. virescens* populations.

Phosphoglucomutase (PGM)

PGM manifested two bands, but with very close mobilities and no variation among the individuals in the populations. Hence PGM could be considered to represent a single locus. The bands were of identical mobilities 0.24 and 0.19 in all three populations.

Discussion

Of the eight enzyme systems studied, all except EST possessed bands with virtually identical relative mobilities in the three populations of *N. virescens*. The bands of the other seven enzymes appear to be homologous across the populations from India, Sri Lanka and the Philippines.

Est-1 had bands with virtually identical mobilities across the populations. Both Est-2 and Est-3, though possessing identical relative mobilities in India and Sri Lanka populations, differed from the Philippines population. Thus Est-2 and Est-3 gave diagnostic differences which are clear enough to allow separation of the Philippines population from the other two populations.

Of the total of 14 presumptive loci in the eight enzyme systems, only two, Est-2 and Est-3, had differing relative mobilities between the two geographically different groups of India and Sri Lanka populations when compared to the Philippines population. This Intra-species genetic divergence between geographically distant populations of *N virescens* appears to be correlated with the partial reproductive isolation induced by differences in acoustical behavior. Yusof (1982) reported that pulse repetition frequencies of *N virescens* from Sri Lanka differed significantly from that of *N. virescens* population from Malaysia, which approximated the pulse repetition frequencies of *N. virescens* from the Philippines.

Claridge *et al.* (1984) also reported that pulse repetition frequency may be an important element endowing specificity to male calls in another homopteran, *N. lugens*. Claridge *et al.* (1985) also reported that the differences between pulse repetition frequencies of *N. lugens* were distinctive for populations from different geographic regions.

The more intense staining of Est-1 in the females indicates a higher degree of esterase activity and hence Est-1 may be sex related in *N. virescens*. Differential esterase staining intensity was reported between the males and females in *S gatella furcifera* Horvath population from Sri Lanka on polyacrylamide gels by Rajendram (1990) who noted a more intense staining among males Sex-linkage in esterase has also been reported in the caddisfly *Triaenodes tardus* Milne (Steiner *et al.* 1983.)

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SOME OBSERVATIONS ON THE POWDERY MILDEW DISEASE OF SESAME (*SESAMUM INDICUM* L.)

JEYADEVI KAILAYAPILLAI,[1] A. SIVAPALAN[2] & K. THEIVENDIRARAJAH

(Department of Botany, University of Jaffna, Sri Lanka)

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ABSTRACT: This study describes the morphology of powdery mildew fungus at various developmental stages in its life cycle and the symptoms produced on different parts of the sesame plant. Under natural conditions the infection first appeared as small tiny white superficial patches on the upper surface of mature leaf of a plant at the age of 40 days or more. Symptoms include surface leaf necrosis, premature leaf fall, stunted growth of the plant at early stage, yellowing and chlorosis of leaf at mature stage and browning of flower buds. Life cycle of powdery mildew was initiated by air-borne conidia, measured 25—36 μm in length and 14—18 μm in breath. At 25$\pm$1°C and 100% R H. conidia started to germinate in about 4 hours and germination was maximum at about 24 hours after incubation. The penetration of the host tissue was completed within 28 hours. The second germtube was observed after about 30 hours and the third after about 36 hours of incubation. Secondary elongating hyphae, conidiophore initials and abstriction of conidiophore were observed 60, 144 and 156 hours after incubation respectively. The colony produced maximum amount of conidia on the ninth day after incubation. The colony remained productive even upto 12 days from the time of inoculation.

Introduction

One of the important diseases of sesame (*Sesamum indicum* L.) is the powdery mildew disease. The disease is caused by a fungus of which the conidial stage is *Oidium* and belongs to Erysiphaceae. The fungus responsible for sesame powdery mildew was named *Oidium erysiphoid* by Roy (1965), *Oidium* species by Senewiratne and Appadurai (1966) and *Levellula taurica* by Rangaswamy (1979). The fungus in the present study was named *Oidium* species following the identification at Commonwealth Mycological Institute, U. K.

1 Present address : *Regional Office, Department of Agrarian Services, Puttur, Jaffna.*

2 Present address : 2/69 *Nell Street, Greensborough, Victoria, Australia.*

The fungus is an obligate parasite which cannot be cultivated *in vitro*. Some of the marked characteristics of powdery mildew are superficial hyaline mycelium, haustoria in the epidermal cells of the hosts, luxuriant development in dry weather, high water content of the air borne conidia, diurnal periodicity with respect to several characters, compatible association with their hosts and vulnerability to control by fungicides (Yarwood, 1957). The white superficial mycelium and conidia and dark superficial perithecia of the powdery mildew make them among the most easily recognized and best known fungi (Yarwood, 1957).

The powdery mildew disease is observed in almost all fields in Jaffna region during January to July as sesame is cultivated in the area during these particular months. The disease was observed in the glass-house throughout the year. The wide prevalence of this disease in Sri Lanka, particularly in the Jaffna district, and the severity of the disease at times have prompted this investigation.

Materials and Methods

Observations were made on the morphology of powdery mildew at various developmental stages in its life cycle and the symptoms produced on different parts of sesame plants. This study was carried out in field and in laboratory. Observations were taken in the fields of University of Jaffna, Thirunelvely, and in Navali and Velanai. For laboratory experiments, the leaves of the sesame plant of variety TMV_3 were used as the source of host tissue unless otherwise stated.

Source of inoculum

Sesame plants of variety TMV_3 grown in field and pots were allowed to develop natural infection and infections were continuously maintained on fresh potted plants throughout the experimental period.

Method of inoculation

The heavily infected leaves were gently shaken to remove old conidia and were placed on filter paper discs in closed petri dishes in an illuminated incubator. The following day the infected specimens were removed from the incubator and tapped over a cardboard cylinder of 80 cm diameter and 2 m height below which the healthy leaves (upper surface facing upwards) and healthy potted plants were kept. Inoculated leaf discs/leaves were placed on moist filter paper discs, with the inoculated surfaces facing upwards in petri dishes. The filter paper discs were kept wet throughout the experiment in order to maintain high humidity in the environment.

Incubation

Sets of inoculated leaf discs/leaves were incubated at 25°±1°C and 100% RH, in an illuminated incubator. Inoculated potted plants were kept in a glass-house in a humid environment, where humidity was maintained near 100% by placing buckets of water.

Assessment

At the end of incubation, the inoculated leaf materials were taken out of the incubator or were brought from the glass-house and observed under the light microscope.

Germination of conidia

The inoculated leaf materials were taken out of the incubator at two hour intervals starting from the time of inoculation and were examined for germination of conidia. Cellotape impressions of the inoculated surfaces were taken, stained with cotton blue in lactophenol, mounted in glycerine and observed under the light microscope.

The number of germinated and ungerminated conidia were counted with the help of a tally counter. Germination counts were made form ten microscopic fields (× 100) selected at random on each of the ten leaf discs. About 2500 conidia were observed for each treatment and a conidium was considered to have germinated when the length of the germ tube exceeded its breadth (Manners and Hossain, 1963). The mean percentage germination of conidia after different periods of incubation was calculated.

Development of infection

Firstly the growth of germ tube was observed at two hour intervals starting from the time of inoculation up to 24 hours. Inoculated leaf discs/ leaves were removed from the incubator at different time intervals, cellotape impressions of the inoculated surfaces were taken and the impression stained with cotton blue in lactophenol. These preparations were observed under the light microscope and the measurements on the germ tube length of ten randomly selected germinated conidia on each of the five replicates were made under high power objective with the help of an eve piece graticule which had been calibrated previously.

Production of conidiophore

Healthy leaves of sesame inoculated with powdery mildew conidia by tapping method were incubated under optimal conditions in an illuminated

incubator. Samples were taken out at 24 hour intervals and were observed for the formation of conidiophore initials on the colonies. Camera lucida drawings of the colonies were made under light microscope after 144, 168 and 192 hours of incubation.

Apart from these observations, quantitative measurements on the number of conidiophores produced per colony in one sq cm area of the host tissue of all five replicates, after six, seven and eight days of incubation were determined.

Production of conidia

Potted plants of sesame were raised from seeds under glass-house conditions. Five seedlings of five leaf stage were inoculated simultaneously by the tapping method and incubated at room temperature. After five days of incubation inoculated leaves of the ages two and three were harvested randomly from each plant and incubated at 25° C and 100% RH in an illuminated incubator for further seven days. Three one sq cm cellotape impressions were made from each of the five leaves and the number of fresh conidia produced per sq cm area of the leaf on the 7th, 8th, 9th, 10th, 11th and 12th day after inoculation was counted.

Experiments and Results

The disease was observed during February to June 1983, February to July 1984 and January to July 1985. In 1985 the disease was not observed during the month of June. The disease was observed under glass-house conditions throughout 1983 and 1984.

The disease usually appeared in the field in which the age of the sesame plants was more than 40 days. Under natural conditions the lower leaves developed infection first and from these the infection spread to the other leaves and finally to the other parts of the plant. When the temperature of the environment was high the infection appeared on the lower surface of the upper leaves and both surfaces of the lower leaves. About 10–20 days after initial appearance of infection the young leaves also developed infection. Here the infection was greater on the lower surface than on the upper surface. Leaves of young branches developed infection in a way similar to those on the main stem Tender leaves found in a humid environment also developed infection.

Symptoms

Powdery mildew infection on sesame plant has been apparent from seedling stage up to mature plants. All parts of the sesame plant namely the

leaves, stem, flower buds and pods were found to be affected by this fungus. Leaves were found to be the most susceptible tissue to fungal attack. The first symptoms of the infection were the small tiny white almost circular superficial powdery patches on the host surface. These white patches increased in number and size and became powdery in nature. These powdery patches coalesced and eventually covered the entire leaf surface. The visible white patches appeared a day before the appearance of the sporulating structures. The affected portions of the leaves became dry, turned brown and later developed marginal necrosis.

The entire leaf surface already brown and dry curled up and finally dropped off from the plant leaving only the stem. In some cases the heavily infected leaves before showing symptoms of necrosis became pale in colour and dropped off from the plant.

Sesame plants infected at an early stage of growth (about 20 days old) showed reduced or stunted growth. On one occasion in a field where 20 day old plants developed infection, the cultivation was completely abandoned about three weeks after the initial appearance of infection. The infected flower buds became brown, withered and failed to open and develop into pods. During the period of severe disease incidence the pod infection also was observed. Small pods were more susceptible than the mature pods. Due to the pod infection affected pods became pale green in colour and were covered with the powdery mass of the fungus. These pods produced fewer, thinner and smaller seeds than the normal ones.

Infected young stem also was observed in heavily infected sesame fields. Affected stems were covered with powdery mildew fungus. In addition they became slender and lost their rigidity. In such stems only few flower buds were produced.

Life cycle of the fungus

Germination, infection and sproulation follow each other in the life cycle of powdery mildew.

Germination

Life cycle of the powdery mildew is initiated by airborne conidia which are the asexual reproductive spores of the fungus. The conidiophores were elliptical, smooth walled, colourless and vacuolated when fresh. The hyaline conidia measured 25 to 36 μm in length and 14 to 18 μm in width.

When the conditions were favourable germination of the fungus was observed as direct germination of conidia.

The mean percentage germination of conidia after different periods of incubation was calculated. The conidia started to germinate after about four hours and produced a single thick germtube from one corner of the conidia. The mean percentage germination of conidia increased with increase in period of incubation and attained maximum level of 70% around 24 hours after incubation (Fig. 1).

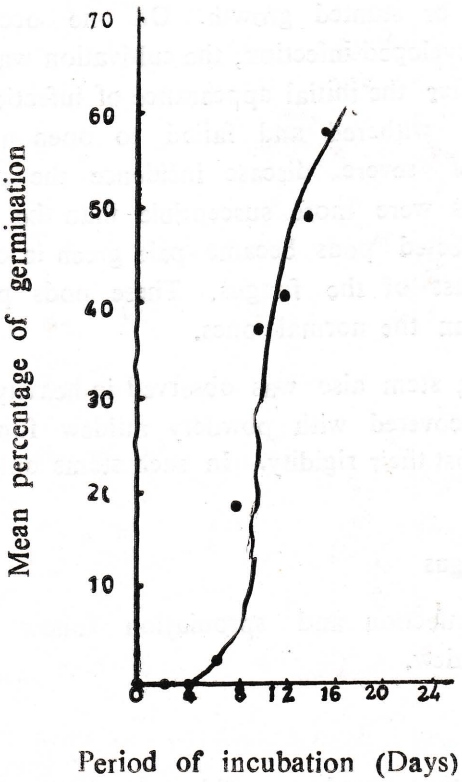

Fig. 1 Germination of conidia of *Oidium* s ecies on leaf discs of sesame after different periods of incubation, at 25°C and 100% RH.

Infection

Firstly the growth of the germtube was observed at two hour intervals from the time of inoculation up to 24 hours. From the data the mean length of germtube after different periods of incubation was determined (Fig. 2). The observation revealed that the conidia germinated after about four hours of incubation and the germtube continued to grow and attained its maximum length at about 10 hours after incubation. Thereafter the mean length of germtube remained more or less constant up to 24 hours. The appressoria were produced on single thick germtube of germinated conidia about 26 hours after incubation.

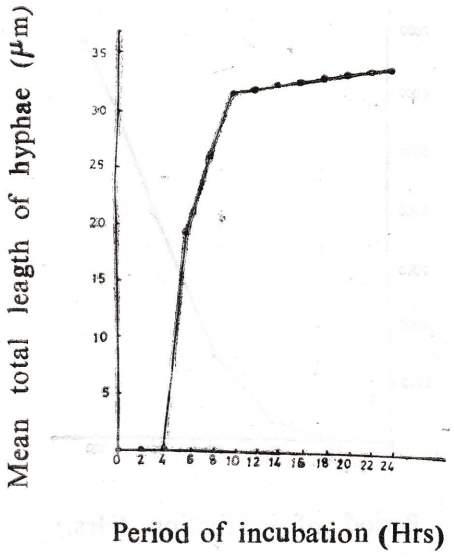

Fig. 2 Growth of germ tube of *Oidium* species on leaf discs of sesame, at 2 hour intervals upto 24 hours of incubation at 25°C and 100% RH.

Since the germinated conidia appeared to have formed additional germtubes after 30 hours of incubation, it was necessary to continue the experiment further to trace the germinating conidia Another experiment was set up in which the measurements on the hyphal growth were made at 24 hour intervals. From these measurements the mean total length of hyphae of each

germinated conidium at 24 hour intervals was determined. These values are expressed in the form of a graph (Fig 3). Mean total length of hyphae increased with increase in period of incubation. Germinating conidia started to produce primary hyphae at about 30 hours after incubation. The elongating secondary hyphae were observed after about 48 hours of incubation while the tertiary hyphae appeared after 36 hours of incubation. After about 60 hours the other hyphae started to elongate soon after the lateral appressoria were formed. Branching of hyphae was observed after about 72 hours of incubation. The white patches of infection became visible to the naked eye only after 120 hours.

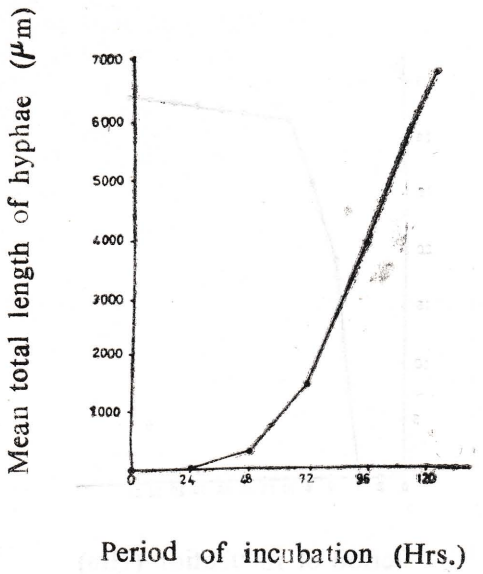

Fig. 3 Growth of hyphae of *Oidium* species on leaves of sesame at 24 hour intervals at 25°C and 100% RH.

Sporulation

Camera lucida drawings of the colonies were made under light microscope. Conidiophore initials appeared 144 hours after inoculation and the typically unbranched and septate conidiophores were formed after 160 hours of incubation. The mature one celled conidia were ready for release after about 160 hours of incubation (Fig. 4).

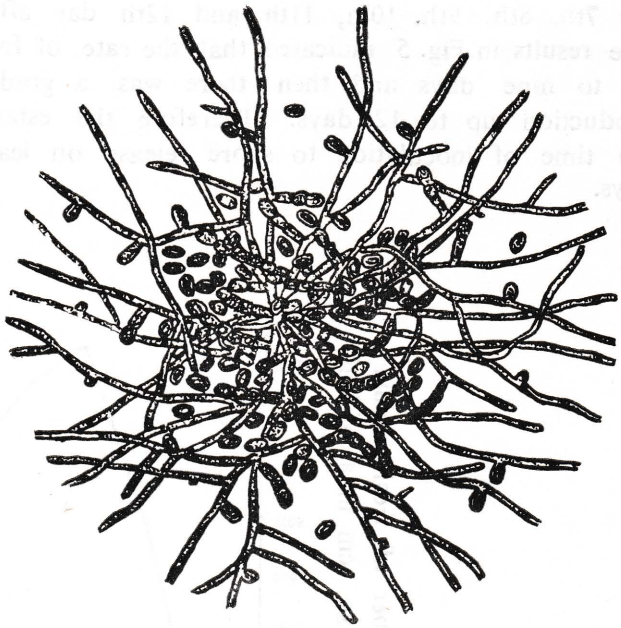

Fig. 4

Camera lucida drawings (×100) of a 198 hour colony of *Oidium* species on sesame leaf at 25°C and 100% RH.

Apart from these measurements, the number of conidiophores produced per colony in one sq cm area of host tissue after six, seven and eight days of incubation were determined. The results in Table 1 revealed that the rate of production of conidiophores increased with increase in period of incubation. The mature conidia were ready for release by about seven days after inoculation and the colony remained productive for a further five days.

Table 1 : The number of conidiophores produced after different periods of incubation 25°C and 100% R H.

Hours after incubation	Number of conidiophores Produced / colony
144	18 a
168	29 b
192	78 c

The values denoted by different letters are statistically different.

The number of fresh conidia produced per sq cm area of the leaf on the 7th, 8th, 9th, 10th, 11th and 12th day after inoculation was counted. The results in Fig. 5 indicated that the rate of fresh conidia produced increased up to nine days and then there was a gradual decrease in the conidial production up to 12 days. Therefore the establishment of the fungus from the time of inoculation to spore release on leaves was found to take nine days.

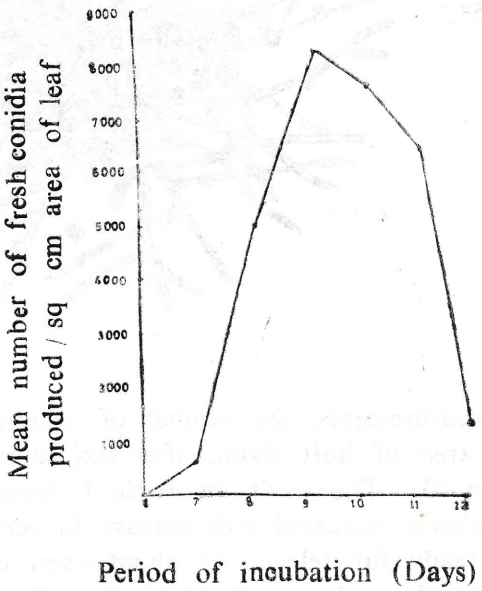

Fig. 5 The production of fresh conidia of *Oidium* species on leaves of sesam at 25°C and 100% RH after different periods of incubation.

Spore release

The conidia were released when the host leaf and the atmosphere were relatively dry, that is during the day time. Detached conidia were taken away by the wind and deposited over the fresh host leaves on which they germinated again.

Sexual reproductive structures of the fungus such as perithecia were not observed during the three years of study.

Discussion

The present studies have established that the causative organism of the powdery mildew disease of sesame in Jaffna is the *Oidium* sp. Though the disease was widespread throughout the year, the severity of the disease was found to be high during the months of September to February. The relatively lower temperature, high relative humidity and reduced sunlight experienced during these months seem to favour the development and spread of the disease. The disease appeared usually in fields where the age of the host plant was more than 40 days. But in shady conditions and with reduced plant spacing the disease appeared earlier.

The fungus was able to establish itself on all parts of the plant but it generally starts on the more mature lower leaves of the stem and on the upper surface. It then quickly spread to both surfaces of the lower leaves and to other leaves, main stem, branches, flower buds and even mature pods. Similar observations, affecting all parts of the plant on a number of other crop plants by *Oidium* sp. have been reported (Cook, 1931; Miller, 1939; Yarwood, 1957 and Wheeler, 1969).

This fungus has a relatively short life cycle of about 12 days. The infection starts with the germination of the conidia on the plant surface. The conidia begin to germinate after four hours and produce white hyphal masses visible to the naked eye in five days. The mycelium starts producing conidia from the 7th day until the 12th day with a maximum production on the 9th day. The conidia were released when the host leaf and atmosphere were relatively dry i.e. during the day time. Detached conidia were taken away by wind and deposited over fresh host leaves on which they germinate again. The survival of the fungus was ensured by active production of conidia.

It was also observed that heavy rains wiped out the infection but soon after the rains the infection appeared only on the lower surface. Mild rains for short period on the other hand lead to luxuriant development of powdery mildew on host surfaces. Greater spacing between plants avoiding over crowding and shade coupled with less frequent irrigation to maintain low relative humidity are some of the practical measures that could be taken to reduce the severity of this disease.

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மார்கழி 1989

இதழ் 4 1-ம், 2 ம் வெளியீடு

விஞ்ஞானம்

விஞ்ஞான சஞ்சிகை

'விஞ்ஞானம்' இதழ் 4 இன் வெளியீடு எமக்கு அப்பாற்பட்ட சூழ்நிலைகளினால் தாமதமாகிவிட்டது. இவற்றில் மிகவும் துக்ககரமான நிகழ்ச்சி முன்னாள் பிரதம ஆசிரியர் S. கந்தையா அவர்களின் திடீர் மறைவாகும். இவர் 'விஞ்ஞானம்' உற்பத்தியான காலத்திலிருந்து இப்பணியினை ஆற்றினார்.

இதழ் 4 இல் பௌதிகத்தில் முதலாவது கட்டுரையை வெளியிடுகிறோம்: K. கந்தசாமி: ''உலோகங்களில் ஐதரசன் பரவல்''.

இரு கட்டுரைகள் இப்பிரதேசத்தின் பயிர்களின் நோய்களைக் குறிக்கும்: K V. S. சுந்தரேசன், பத்மாசனி வரதராஜாவின் கட்டுரை பப்பாசியின் சித்திரவடிவு நோயையும், ஜெயதேவி கைலாயபிள்ளை, K. சிவபாலன், K. தெய்வேந்திரராஜாவின் கட்டுரை எள்ளுத் தாவரத்தின் சாம்பல் பூஞ்சண நோயையும் குறிக்கும்.

G. F. இராஜேந்திரம், நிர்மலா R. அன்ரனி, றோகினி நாகலிங்கம் ஆகியோருடன் யாழ்ப்பாணக் குடாநாட்டின் நுளம்பு பற்றிய முதலாவது ஆய்வை ஆரம்பித்துள்ளார். G. F. இராஜேந்திரத்தின் மற்றொரு கட்டுரை இந்தியா, இலங்கை, பிலிப்பைன் நாடுகளிலுள்ள ஒரு பச்சை இலைத்தத்தின் குடித் தொகைகளினிடையேயுள்ள புவியியல் ரீதியான பரம்பரையியல் வேறுபாடுகளைப்பற்றித் தெரிவிக்கின்றது.

ஆனி 1991 ஆசிரியர்

December 1989

Vingnanam J. Sci. 4 (1989)

இவ்விதழ் கட்டுரைகளின் சுருக்கங்கள்

உலோகங்களின் ஐதரசன் பாயம்

ஆசிரியர் :
K. கந்தசாமி
(பௌதிகவியல் துறை, யாழ்ப்பாண பல்கலைக்கழகம், இலங்கை.)

Vingnanam J. Sci. 4 : 1—7.

சுருக்கம்:

உலோகங்களில் ஐதரசன் பாயத்தின் பரவலுக்கான சமன்பாட்டை பெறுவதற்கு தகைப்புக்குட்பட்ட திண்மத்தில் அசையும் கரை பொருள் பாயத்துக்குரிய சென்-மின்-லீயின் முறை இயல் உபயோகப்படுத்தப்பட்டது. இச் சமன்பாடுகள் ஸ்ரவிஸ் குழுவினரால் அறிவிக்கப்பட்ட பரிசோதனைத் தரவுகளுடன் ஒப்பிடப்பட்டன. இசைவுறு தன்மை திருப்பியாகவுள்ளது.

பப்பாசி சித்திரவடிவு நோயினால் தொற்றுகையுற்ற பப்பாசி (*CASICA PAPAYA* L.) இலைகளில் இருக்கும் சுயாதீன அமினோ அமிலங்களின் ஆராய்வு

ஆசிரியர்கள் :
R. V. S. சுந்தரேசன், பத்மசனி வரதராஜா
(தாவரவியல் துறை, யாழ்ப்பாணப் பல்கலைக்கழகம், இலங்கை.)

Vingnanam J. Sc. 4 : 8 – 13.

சுருக்கம் :

Carica papaya L, C. V. Coimbatore 2, C. P. 124, Local, Solo Hawaii, Unknown Indian ஆகிய குல வகைகளின் ஆரோக்கியமான இலைகளினதும் பப்பாசி இலைச் சித்திர வடிவு நோயினால் தொற்றுகையுற்ற இலைகளினதும் பிரித் தெடுப்பினை அயன் மாற்றீடு நிறப்பகுப்பியல் செய்துபின்னர், இரு பரிமாண தாழ் நிறப் பகுப்பியல் முறையினால் சுயாதீன அமினோ அமிலங்களின் இருக்கைபற் றித் துணியப்பட்டது. Alanine, ∝ – amino butyric acid, arginine, aspartic acid, cysteic acid, glutamic acid, glycine, histidine, isoleucine, leucine, lysine, methionine, phenyl alanine, serine, threonine, tyrosine, valine ஆகிய அமினோ அமிலங்களின் இருக்கை ஆரோக்கியமான இலையினதும், தொற்றுகையுற்ற இலையினதும் பிரித் தெடுப்பிலும் காணப்பட்ட போதிலும் அவற்றின் செறிவு வெவ்வேறு குலவகைகளுக் கிடையில் வேறுபட்டது. சில ஆரோக்கியமான குலவகையிலும், தொற்றுகையுற்ற குல வகையிலும் அமினோ அமிலங்கள் இல்லாமையும், செறிவு மாறுபடுதலையும் காரணம் கூறி விளக்குவதற்கான முயற்சிகள் மேற்கொள்ளப்பட்டது.

யாழ்ப்பாணக் குடாநாட்டின் வீட்டுப்புற நுளம்பு இனங்களின் உயிரியல்

ஆசிரியர்:
G. F. ஞானேந்திரம், நிர்மலா R. அன்ரனி, றேகினி நாகலிங்கம்
(விலங்கியல் துறை, யாழ்ப்பாண பல்கலைக்கழகம், இலங்கை)

Vingnanam J Sci. 4 : 14—19.

சுருக்கம் :

யாழ்ப்பாணக் குடாநாட்டின் மூன்று இன வீட்டுப்புற நுளம்புகளின் உயிரியல் ஆராயப்பட்டது. *Aedes aegypti* Linnaeus, *Armigeres durhami* Edwards, *Culex quinquefasciatus* Say. *A. aegypti* யின் பல்வேறு நிலைகளின் சராசரி விருத்திக் காலமானது: முட்டை 1.69 நாட்கள், குடம்பி 4.5 நாட்கள், கூண்டுப்புழு 6.7 நாட்கள். மொத்தவிருத்திக் காலம் 12.9 நாட்கள். *A. durhami* யின் விருத்தி நிலைகளின் சராசரிக் காலம்: முட்டை 3.12 நாட்கள், குடம்பி 6.84 நாட்கள், கூண்டுப்புழு 4.04 நாட்கள். மொத்த விருத்திக்காலம் 14.0 நாட்கள். *C. quinquefasciatus* இன் இளமைப் பருவங்களின் சராசரிக் காலம் : முட்டை 5.6 நாட்கள், குடம்பி 5.8 நாட்கள், கூண்டுப் புழு 2.9 நாட்கள். மொத்த விருத்திக்காலம் 14.3 நாட்கள். மூன்று இனங்களினதும் விருத்திக்காலம் வெப்பநிலையில் தங்கியிருப்பதாகக் காணப்படுகிறது.

இந்தியா, இலங்கை, பிலிப்பைனின் *Nephotettix virescens* (Homoptera : Cicadellidae) குடித் தொகைகளின் நொதியங்களின் மின் பகுப்பு ஆய்வு

ஆசிரியர்
G. F. இராஜேந்திரம்
(விலங்கியல் துறை, யாழ்ப்பாண பல்கலைக்கழகம், இலங்கை.)

Vingnanam J. Sci. 4 : 20—26.

சுருக்கம்:

எட்டு கரையக்கூடிய நொதியங்களின் பட்டிகை மாதிரிகள், எஸ்ரேசு (Est), குளுக்கோசு 6 பொஸ்பேற் டீஐதரசனேசு (G-6-PHD), எக்ஸ்சோகைனேசு (HK), ஐசோசித்திரேற்று டீஐதரசனேசு (IDH), மலேற் டீஐதரசனேசு (MDH), லக்ரேற் டீஐதரசனேசு (LDH), மலிக் நொதியம் (ME), பொஸ்போகுளுக்கோமியூட்டேசு (PGM) ஆகியன, இந்தியா, இலங்கை, பிலிப்பைன் தீவுகளிலிருந்து சேகரிக்கப்பட்ட *Nephotettix virescens (Distant)* குடித்தொகைகள், ஐக்கிய இராச்சியத்திலுள்ள, காடிவ்ப், வேல்ஸ் பல்கலைக்கழகத்தில், கண்ணாடி – வளர்ப்பு இல்லங்களில், TNI நெல்லினத்தில், பராமரிக்கப்பட்ட வளர்ப்புகளில் ஆராயப்பட்டன. இரு இலிங்க நிறைவுடலி பூச்சிகளிலும், எட்டு நொதியங்களுக்கான மாப்பொருள் ஜெல் மின்நுண்பகுப்பையும் (electrophoresis) ஜெல் சாயமூட்டலையும் பாவித்து இவ்வாய்வு மேற்கொள்ளப்பட்டது. ஏழு நொதியங்களின் பட்டிகைகள், மூன்று குழுத்தொகைகளிலும், எண்ணிக்கையிலும், சார் அசைவிலும் இணக்கமடைந்திருந்தன.

எஸ்ரரேசில், மூன்று வலயங்களின் தொழிற்பாடு எல்லா மூன்று குடித்தொகைகளி லும் அவதானிக்கப்பட்டது. இருபட்டிகைகளின் சார் அசைவு, பிலிப்பைன் தீவுகளிலிருந்து பெறப்பட்ட குடித்தொகையில் இந்தியா, இலங்கையின் *N. virescens* இலிருந்து, வேறுபட்டிருந்தது. அத்துடன் பிலிப்பைன் குடித்தொகையை இனங்கண்டு வேறுபடுத்த இது பயன்படுத்தப்படலாம். எஸ்ரரேசு 1 பட்டிகைகள் இலிங்கத்துடன் தொடர்புடை யனவாக, பெண் பூச்சிகளில் அவை அதிகளவில் கடுமையாகவும் தோன்றின. இப்பெறு பேறுகள் முன்னர் அவதானிக்கப்பட்ட இலங்கை பிலிப்பைன் தீவுகளிலிருந்து பெறப்பட்ட *N. virescens* இன் ஒலியியல் நடத்தையுடனும், இரு குடித்தொகைகளுக்கிடையிலான பகுதி இனப்பெருக்க தனிப்படுத்துகை தூண்டுவதிலும் ஒத்திருக்கக்காணப்பட்டன.

எள்ளு தாவரத்தில் தோற்றுவிக்கப்படும் சாம்பல்பூஞ்சண நோயின் சில அவதானங்கள்.

ஆசிரியர்கள் :
ஜெயதேவி கைலாயபிள்ளை A. சிவபாலன், K. தெய்வேந்திரராஜா.
(தாவரவியற்றுறை, யாழ்ப்பாண பல்கலைக்கழகம், இலங்கை)

Vingnanam J. Sci. 4 : 27—38.

சுருக்கம் :

எள்ளு தாவரத்தில் சாம்பல் பூஞ்சணத்தின் வாழ்க்கைவட்டத்தின் வெவ்வேறு விருத்தி நிலைகளின் உருவவியலையும், எள்ளு தாவரத்தின் வெவ்வேறு பாகங்களில் ஏற்படுத்தும் நோயறிகுறிகளையும் பற்றிய படிப்பு மேற்கொள்ளப்பட்டது. இயற்கை நிபந்தனைகளில் தொற்றுதலானது 40 வயது அல்லது அதற்கு மேற்பட்ட தாவரத் தின் முதிர்ந்த இலையின் மேற்பரப்பில் சிறிய துண்ணிய வெள்ளைப்படையாக முத லில் தோன்றியது. இலைப்பரப்பு இறத்தழிதல் முன்முதிர்ந்த இலைவீட்சி, ஆரம்பநிலை யில் தாவரத்தின் குறள் வளர்ச்சி, மஞ்சளாதல் முதிர்ந்த நிலையில் இலையின் பச்சை அழிதல், பூ அரும்புகளின் மண்ணிறமாதல் ஆகியன நோயறிகுறிகளுள் அடங்கும் இச் சாம்பல் பூஞ்சணத்தின் வாழ்க்கை வட்டமானது 25 – 36 µm நீளமும் 14 – 18 µm அகலமும் உடைய வளியிலுள்ள தூளிய வித்துக்களால் தோற்றுவிக்கப்பட்டன தூளிய வித்திகளானது 25±1°C யிலும், 100% சாரீரப் பதனிலும் 4 மணித்தியாலத்தில் முளைக்க ஆரம்பித்தன. 24 மணித்தியால அடைகாத்தலின்பின் முளைத்தல் அதி உயர்வாக இருந்த தது. இந்நோயாக்கியானது விருந்து வழங்கியில் 28 மணித்தியாலத்தில் ஊடுருவியது. இரண்டாவது மூலவுயிர்க் குழாயானது 30 மணித் யாலத்தின்பின்பும் மூன்றாவது மூல வுயிர்க்குழாயானது 36 மணித்தியால அடைகாத்தலின் பின்பும் அவதானிக்கப்பட்டது. துணையான நீளும் பூஞ்சண இழை, தூளியந்தாங்கி முதல்கள், தூளியந்தாங்கியின் சுருங் கியனுதல் ஆகியன முறையே 64, 144, 156 மணித்தியால அடைகாத்தலின்பின் அவ தானிக்கப்பட்டன. சமுதாயமானது 9 நாள் அடைகாத்தலின்பின், அதிகூடிய தூளியவித் திகளைத் தோற்றுவித்தது சமுதாயமானது உட்புகுத்தலிலிருந்து 12 நாட்களின் பின்பும் உற்பத்தியாக்கும் திறனைக் கொண்டிருந்தது.

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All illustrations are considered as figures and each graph, drawing or photograph should be numbered in sequence with Arabic numerals. Authors must submit the original and two duplicates of each figure. Figures should be planned to fit the proportions of the printed page. The maximum space available on a page is 140 × 190 mm.

Figures must be drawn in Indian ink on plain white paper or board tracing paper, not larger than twice the linear dimensions desired. Drawings should be lettered with a lettering set; lettering should be kept large enough to be clearly legible after a reduction of 50 to 60%; if this is not possible all letters and numerals must be inserted clearly and lightly in blue pencil and not in ink. Wherever possible small figures should be grouped to fill a page.

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All references to publications made in the text should be presented in a list of references following after the text of the manuscripts. The manuscripts should be carefully checked to ensure that the spelling of authors names and dates are exactly

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JOURNAL

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BOOK

Slatyer, R. O. (1967) *Plant Water Relationships.* Academic Press, London. 366 pp.

SECTIONS OF BOOK

Skoog, F. & Miller, C.O. (1957) Chemical regulation of growth and organ formation in plant tissue cultured in Vitro. pp. 118 - 131. In *Symposia for the Society of Experimental Biology XI. The Biological action of growth substances* University Press, Cambridge.

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Formulae should be typewritten, if possible, leaving ample space around the formulae. Subscripts and superscripts should be set off clearly. Greek letters and other non-Latin or handwritten symbols should be explained in the margin when they are first used. Take special care to clearly show the difference between zero (O) and the letter O, and between one (1) and the letter l. Give the meaning of all symbols immediately after the equation in which they are first used. For simple fractions use the solidus (/) instead of a horizontal line,

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