Rice Sheath Mite *Steneotarsonemus spinki* Smiley (Acari : Tarsonemidae)

Status Paper

by

N. Srinivasa
H. Prabhakara
B. Mallik

All India Network Project on Agricultural Acarology
Department of Entomology
University of Agricultural Sciences
GKVK, Bangalore 560065, Karnataka, India
http://www.acarologyindia.org

Rice Sheath Mite
Steneotarsonemus spinki Smiley
(Acari : Tarsonemidae)

Status Paper
by

N. SRINIVASA
H. PRABHAKARA
B. MALLIK

ALL INDIA NETWORK PROJECT ON AGRICULTURAL ACAROLOGY
Department of Entomology
University of Agricultural Sciences
GKVK, Bangalore 560065, Karnataka, India
http://www.acarologyindia.org

Citation : **Srinivasa, N., Prabhakara, H. and Mallik, B., 2004. Rice Sheath Mite *Steneotarsonemus spinki* Smiley (Acari : Tarsonemidae). 24 pp, AINP (Agricultural Acarology), UAS, Bangalore.**

Published by :
Network Co-ordinator
All India Network Project (Agricultural Acaralogy)
Department of Entomology
University of Agricultural Sciences
Bangalore - 560 065

Cover Photo : Rice panicle showing damage by *Steneotarsonemus spinki*

November, 2004

No. of Copies : 500

Printed at :
Navbharath Enterprises
Seshadripuram, Bangalore - 560 020
Ph : 2336 4142, 2336 4682
E-mail : navbarat@blr.vsnl.net.in

Foreword

In recent times mites are gaining importance as pests of crops and one such instance is the outbreak of coconut eriophyid mite in southern parts of the country. Earlier records only highlighted the nature of damage caused by mites on wheat, tea, pigeonpea and vegetable crops like okra, brinjal etc. However, since 1988 the actual economic loss inflicted by such damages has been estimated following extensive studies on mite pests of crops like vegetable crops (25-30%), chilli (35-40%), pointed gourd (22%) and coconut (30-40%). In 1987, the Indian Council of Agricultural Research strengthened the acarological research in the country by establishing the All India Coordinated Research Project on Agricultural Acarology.

Rice being a staple food crop is menaced by two species of mites ; the spider mite *Oligonychus oryzae* causes damage to the foliage, while the tarsonemid *Steneotarsonemus spinki* causes damage to the sheath and the developing grains as well. The damage by the latter species was reported as early as 1978 in India, this mite has been observed to be a serious pest in parts of Orissa (Cuttack). Since the last 4-5 years the report of its damage is recorded from East and West Godavari districts of Andhra Pradesh and throughout the state of Karnataka.

Application of dicofol at heading stage significantly reduces the incidence of sheath mite as well as the extent of chaffyness and grain discolouration. Now the reports of occurrence of this mite on rice are pouring in from South Gujarat also. In this context, the All India Network Project (formerly All India Coordinated Research Project) on Agricultural Acarology is bringing out a book on the status of this mite in the country and this book also contains the outcome of research on this mite under the AINP umbrella. I immensely congratulate the authors for this timely publication during the International Year of Rice, which would provide avenues for rice entomologists to intensify studies on this mite pest of rice in the country.

Dr. G. Kalloo
Deputy Director General (Horticultural & Crop Science)
Indian Council of Agricultural Research, New Delhi

MESSAGE

I am extremely happy that the year 2004 being the International Year of Rice has seen the light of the compilation of information on rice sheath mite in the country, which is authored by the scientists of All India Network Project on Agricultural Acarology. This tarsonemid mite earlier known from the eastern state of Orissa is now invading the rice crop in other states like Andhra Pradesh and Karnataka in the South and Gujarat in the West. The book features all the aspects of the mite including its management. I very much appreciate the authors for this thoughtful act of publishing this book, which is not only informative, but also provides guidelines for intensification of research on this mite pest.

Dr. O.P. Dubey
Asst. Director General (Plant Protection)
Indian Council of Agricultural Research, New Delhi

Rice Sheath Mite *Steneotarsonemus spinki* Smiley (Acari : Tarsonemidae)

Introduction

Rice, *Oryza sativa* Linnaeus is an important cereal crop and staple food for more than 65 per cent of the worldís population (Mathur *et al.,* 1999). It is cultivated in almost all Tropical, Subtropical and Temperate countries of the World between 43° N and 39° S Latitude and upto an elevation of 2500 MSL, on 146 million hectares. It is especially important in Asia, where 97 per cent of the worldís rice is grown. The worldís annual production is 535 million tonnes of rough rice, 91 per cent of which is produced in two Asian countries, Peopleís Republic of China (including Taiwan) and India. In India, it is grown in 44.97 million hectares in diverse ecological situations with an annual production of 86.3 million tonnes and a productivity of 1990 kg/ha.

Several pests *viz.,* stem borers, thrips, grasshoppers, leafhoppers, planthoppers, caseworms, leaf folders, mites, white tip nematode, pathogenic fungi, bacteria and viruses cause extensive damage to rice crop and also deteriorate grain or seed quality (Goto *et al.,* 1987 ; Prakash and Kaurav*,* 1982 ; Rubia and Shephard, 1988 ; Rao and Prakash, 1992). Of these pests, mites being microscopic are least studied and thus poorly understood by the researchers as well as by the rice farmers, especially in India.

Of the several species of mites reported so far on rice (Rao *et al*., 1993 ; Rao and Prakash, 1995), the tetranychid mite, *Oligonychus oryzae* Hirst infests the leaves, leading to yellowing and drying of the leaves. This mite has been reported to cause economic damage to the crop in Raichur district of Karnataka (Anonymous, 1997-1998) and Kanyakumari and Vellore districts of Tamil Nadu (Anonymous, 1999-2000). Another species of mite, *Steneotarsonemus spinki* Smiley, which belongs to the family Tarsonemidae infests the leaf sheath causing brown discolouration. Infestation of this mite on panicles causes chaffy grains and also discolouration of filled grains. This mite has been reported from Taiwan (Chen *et al.*, 1979), Cuba (Ramos and Rodriguez, 1998) Philippines (Sogawa, 1977) and Madagascar (Gutierrez, 1967). In India, it has been reported from Orissa (Rao and Das, 1977; Rao and Prakash, 1992) and from East and West Godavari districts of Andhra Pradesh (Rao *et al*., 2000; Anonymous 2000-01).

Occurrence of *Steneotarsonemus spinki* Smiley on rice in India and other countries

Steneotarsonemus spinki lives in colonies within the intercellular air spaces of the upper part of leaf sheath and occasionally in the basal part of the mid rib of leaf blades (Sogawa, 1977). In Taiwan, this mite was observed to feed on the leaf sheaths of rice plant even in submerged conditions, but no significant damage or loss due to feeding of the mite was observed (Tseng and Lo, 1980). Lo and Ho (1979) observed these mites between kernel and hull of the grain in Taiwan.

In India, Rao and Das (1977) reported *S. spinki* infestation causing necrotic lesions on leaf sheath and poorly exerted ear heads with brown to black glumes having shriveled ovaries within during November 1975 at the Central Rice Research Institute, Cuttack, Orissa. During 1989-91, paddy fields surveyed in coastal Orissa revealed the infestation of *S. spinki* on rice varieties, particularly Kaurav, Pankaj, Jaya, Krishna, CRM-25, and Gourav. Mites were observed to live in colonies of 10-450 in-between the leaf sheath and the stem and feed on the tissues (Rao and Prakash, 1992). During the wet season of 1999, rice varieties MTU 1001, MTU 2067, MTU 2077, MTU 7029, BPT 5204 and PLA 1000 were found affected most by this tarsonemid mite in 23 villages of East and West Godavari districts of Andhra Pradesh, about 21% of the rice growing area was affected (Rao *et al*., 2000).

Extensive survey for the occurrence of tarsonemid mite in major rice growing districts in Karnataka namely, Bangalore, Bellary, Dakshina Kannada, Kodagu, Mandya, Mysore, Raichur and Shimoga was carried out at heading stage of the crop during kharif 2001 and summer 2002. Mite infestation was identified based on the damage symptoms like necrotic spots/lesions on midrib of the leaves and brownish discolouration on the leaf sheath. The number of rice hills infested by the mite in a randomly selected one m^2 area (minimum of three spots in one acre) was recorded. From these spots five flag leaves along with the panicles were randomly sampled and brought to the laboratory in polythene bags to record the number of eggs and other stages of the mite under a stereobinocular microscope. On the leaf blade, length of the necrotic spots/lesions (in cms) and the number of eggs and other stages of the mite within were recorded. Similarly on the leaf sheath, length of the discoloured patch (in cms) along with the number of eggs and other stages of the mite was recorded (Table 1) (Prabhakara, 2002).

Damage

Mites, which live in colonies within the intercellular spaces of the upper portion of the leaf sheath and occasionally in the basal portion of the mid rib of leaf blades caused necrotic streaks in the interveinal epidermis (Sogawa, 1977). In Taiwan, Ou *et al.* (1977) found *S. spinki* as a major cause of rice grain sterility, about 20% crop of Japonica varieties was severely damaged in about 2000 hectares of paddy fields and *Steneotarsonemus furcatus* De Leon generally found in association with *S. spinki,* was also observed to cause grain sterility in rice panicles (Zhang, 1984). Emmanouel (1981) opined that mite feeding on the floral parts of rice caused considerable grain sterility in Greece. Infested rice plants exhibited significant increase in sterility rate and reduction in panicle neck length indicating that the mite was the main cause of empty heads (Lo and Ho, 1979). Ramos and Rodriguez (1998) reported that *S. spinki* caused unfilled grains syndrome in rice panicles in Cuba. The two genera of Tarsonemidae, *Tarsonemus* and *Steneotarsonemus* were predominant and regularly found to attack rice plants directly or indirectly and caused deterioration of grain quality, characterized as sterile grain syndrome with loose and brownish flag leaf sheath, twisted panicles and impaired grain development resulting in empty or partially filled grains (Chen *et al.,* 1979 ; Feng, 1980). In Korea, rice plants infested by mites showed deformed panicles and inflorescences, lesions on the inner surface of leaf sheaths and browning of the rice hulls (Cho-Myoung Rae *et al*., 1999).

In the Indian state of Orissa, mite infested plants showed necrotic leaf sheaths and poorly exerted ear heads with shriveled ovaries and brown to black lemma and palea (Rao and Das, 1977). Typical symptoms after feeding by these mites included chlorosis, malformed leaves, cracking, rosetting, poor grain development, dwarfism, grain sterility and discolouration, delay in growth and die back (Rao and Prakash, 1992). The symptoms like black lesions in the leaf sheath, discoloured grains, complete or partial chaffy grains and various other deformities were observed in parts of Andhra Pradesh (Rao *et al*., 2000). The tarsonemid mites were observed to feed on leaves, flowers, grains, and soft stems. Ghosh *et al.* (1999) opined that grain deterioration was characterized by ill filled chaffy and discoloured grains and the extent of grain deterioration was high in medium irrigated varieties.

Mite infestation in panicles resulted in poor exertion of ear heads and mite feeding on developing grains caused brown to black discolouration of the glumes externally and the ovary within was shriveled. As a result, symptoms like ill filled or chaffy grains with or without discolouration of the glumes and filled grains with partial or complete discolouration of glumes were observed. Damage due to feeding by mite like, necrotic spots/lesions on leaf blade *(Plate 1)* and discolouration on leaf sheath *(Plate 2),* discoloured chaffy grains, chaffy grains without discolouration, partially and completely discoloured grains (sampled at milky stage or dough stage) recorded the presence of eggs and other stages of the mite *(Plate 3).* Mite feeding in the region between stem and the inner surface of (flag) leaf sheath caused discontinuous brownish streaks, which later coalesced leading to continuous discolouration of the sheath, almost to its entire length (Prabhakara, 2002).

Table 1. Occurrence of tarsonemid mite, *Steneotarsonemus spinki* on rice in Karnataka

a) Kharif 2001

Location	*Varieties*	*Percentage of hills infested by mites*	*Leaf blade*		*Leaf sheath*		*Mean no. of mites per five grains*
			Mean length of necrotic spot (cm)	*Mean no. of mites*	*Mean length of discolouration (cm)*	*Mean no. of mites*	
Hebbal (Bangalore)	HR 12	30	0.6	39.6	5.20	20.0	1.0
	IR 36	42	0.5	46.4	10.80	22.2	0.4
	IR 64	50	0.5	54.4	9.20	29.8	0.7
	Mukthi	48	0.6	31.7	7.0	20.4	0.5
Siruguppa (Bellary)	Early Sona 4	10	0.6	20.8	0	0	0
	Early Sona 11	12	0.6	26.7	3.2	0	0.8
	Early Sona 23	14	0.6	32.5	0	0	0
	Early Sona 16	14	0.6	14.0	0	0	0
	Kavya 2	14	0.7	33.4	0	0	1.7
	IET 15844	18	0.5	3.8	0	0	0
	Early Sona 12	20	0.5	41.0	0	0	0
	IR 60	24	0.5	17.4	0	0	0.9
	Kavya 3	26	0.6	19.2	0	0	0
	IET 16783	26	0.4	23.8	0	0	0.3
	Jaya	26	0.4	22.2	0	0	0.3
	Early Sona 7	30	0.6	16.6	0	0	0
	IET 13542	30	0.4	14.6	0	0	0.3
	Ratnachuda	32	0.6	14.4	0	0	0
	Early Sona 8	34	0.6	40.0	4.60	0	0.8
	Sonamasuri	36	0.7	17.3	0	0	0.6
	Early Sona 9	36	0.6	35.5	0	0	0
	Rajkamal	38	0.7	20.8	0	0	0
	Early Sona 13	40	0.5	39.2	0	0	0
	Kavya 4	40	0.7	20.8	0	0	0
	Early Sona	42	0.5	23.1	0	0	0.4
	Early Sona 22	42	0.6	36.5	0	0	0.5
	BPT 5204	42	0.6	30.1	0	0	0
	Early Sona 21	44	0.4	41.8	0	0	0
	Early Sona 10	46	0.6	45.7	0	0	0
	Lokanath 505	50	0.7	24.8	0	0	0.8
	Early Sona 20	58	0.6	33.4	0	0	0.7
	KRH 2	60	0.6	32.2	0	0	0
	Kavya 5	70	0.7	47.0	0	0	0.9
Hagaribom-manahalli	IR 64	40	0.8	41.0	0	0	0
Brahmavara (Dakshina Kannada)	TN 1	-	0.2	21.6	9.20	14.6	0.6
	Phalguna	-	0.0	0.0 0	8.50	0	0
	Abhay	-	0.3	24.8	8.20	11.3	0.8
	Velluchera	-	0.0	13.0	4.33	20.5	0.7

Contd.Ö

Location	*Varieties*	*Percentage of hills infested by mites*	*Leaf blade*		*Leaf sheath*		*Mean no. of mites per five grains*
			Mean length of necrotic spot (cm)	*Mean no. of mites*	*Mean length of discolouration (cm)*	*Mean no. of mites*	
Kankanady	IET 14758	26	0.4	6.0	32	9.0	0.9
	MO 4	30	0.1	3.6	6.2	5.6	0.2
	KCP 1	40	0.2	14.2	36.8	6.8	0.2
Ponnampet (Kodagu)	Jeerige Sanna	30	0.4	0	0	0	0
	Sabita	32	0.4	0	0	0	0.5
	Hemavathi	36	0.4	2 0	0	0	0
	Biliya	40	0.4	0	0	0	0
	Intan	50	0.4	58.4	0	0	0
Manvi (Raichur)	Sonamasuri	67	0.7	29.3	0	0	0.3
Honnaville (Shimoga)	Jaya	-	5.2	36.3	38.0	16.8	0.7
	Emergency sona	-	0.5	5.0	17	15.0	0
	Mandya vijaya	-	0.7	47.0	10.5	4.8	0.7
	Shikaripura local	-	0.6	21.0	24	13.2	0.5
	Rasi	-	0.6	23.4	22	10.2	0.5
	IR 64	-		21.2	20.6	9.8	0.3
	Tarouri Basumath	-		0	0.6	6.0	0
	Hemavathi	-		8.8	23.0	8.8	0.4
	Aishvarya	-		24.0	35.8	11.6	0.7
	Arkavathi	-		38.0	30.4	10.4	1.0
	Faro 37	-		32.8	32.8	8.6	0
Mandya	Phalguna	<1		16.0	11.6	8.4	0.5
Mysore	BR 2655	-		38.8	-	-	-
	IR 30684	-		0	-	-	-
	Mangalal	-		0	-	-	-
	KHRS10	-		0	-	-	-
	IR 80364	-		0	-	-	-
	Bangla rice	-		0	-	-	-
	Mysore Local	-		0	-	-	-
	Jaya	-		61.6	-	-	-
	Rasi	-		14.4	-	-	-
	Aishwarya	-		12.6	-	-	-
	MTU 1001	-		5.6	-	-	-
	Jyothi	-		0	-	-	-

Contd.Ö

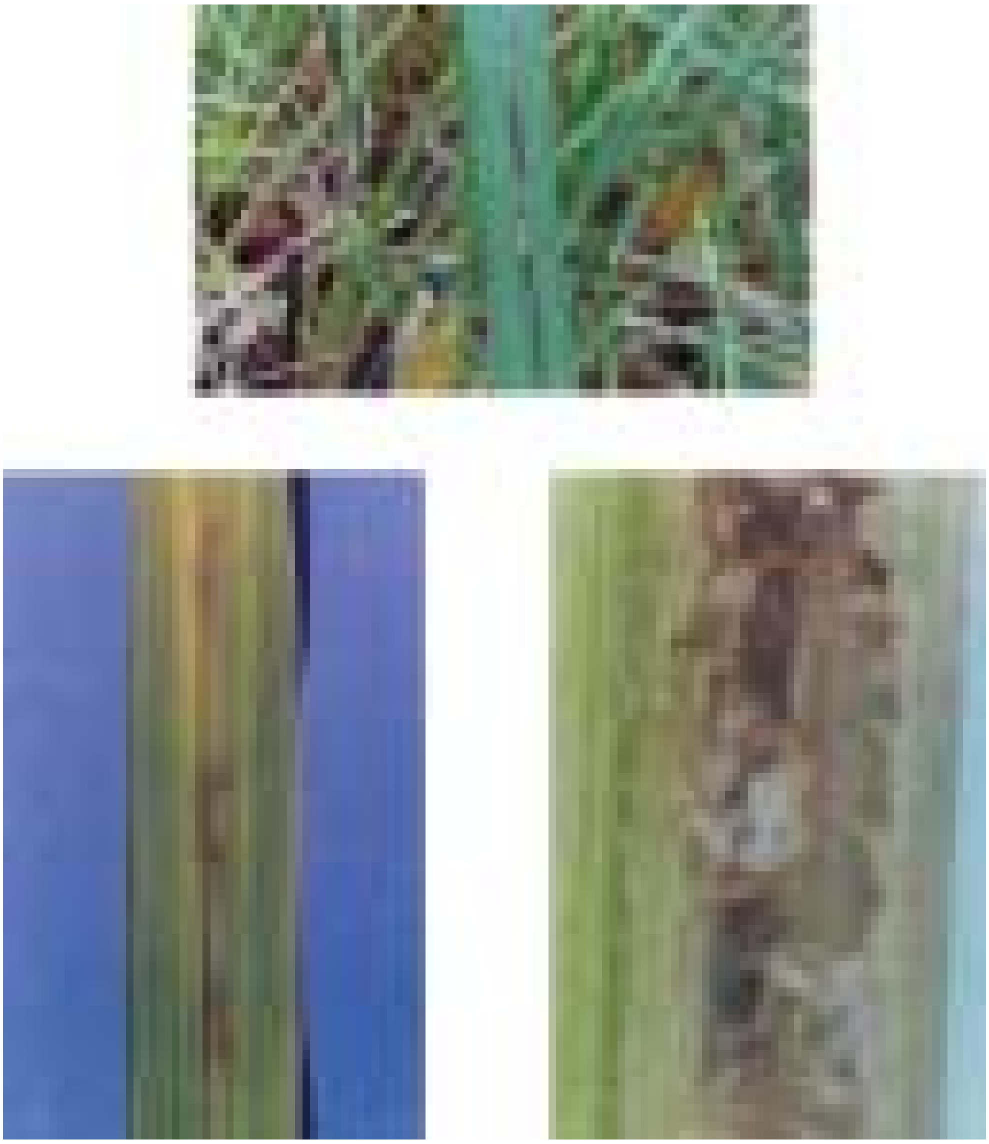

Plate 1

a & b. Damage caused by *Steneotarsonemus spinki* on rice leaves - necrotic spot on midrib
c. Colonies of *Steneotarsonemus spinki* within the midrib in the region of necrotic spot

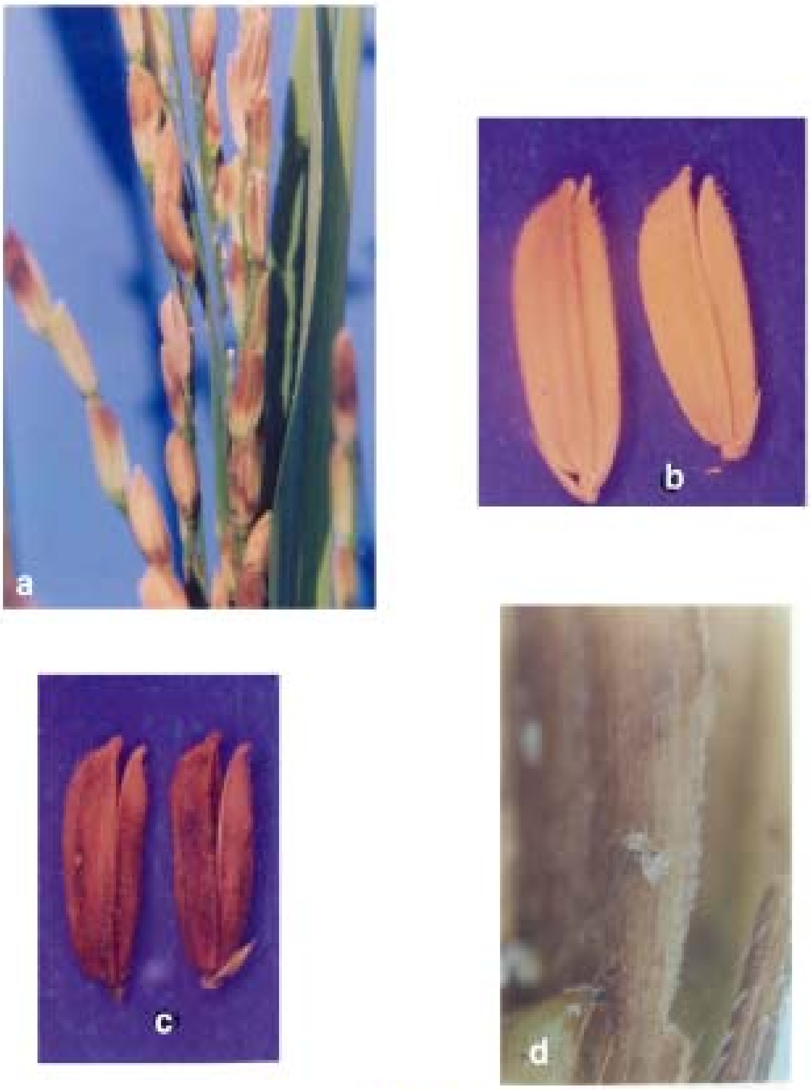

Plate 3

a. Grains in a panicle damaged by *Steneotarsonemus spinki*

b. Chaffy grains without discolouration of glumes

c. Chaffy grains with discolouration of glumes

d. *Steneotarsonemus spinki* feeding inside the developing grains

Plate 2

a & b. Damage caused by *Steneotarsonemus spinki* on rice leaf sheath (brown discoloured region)

c. Colony of *Steneotarsonemus spinki* in the discoloured region of the leaf sheath

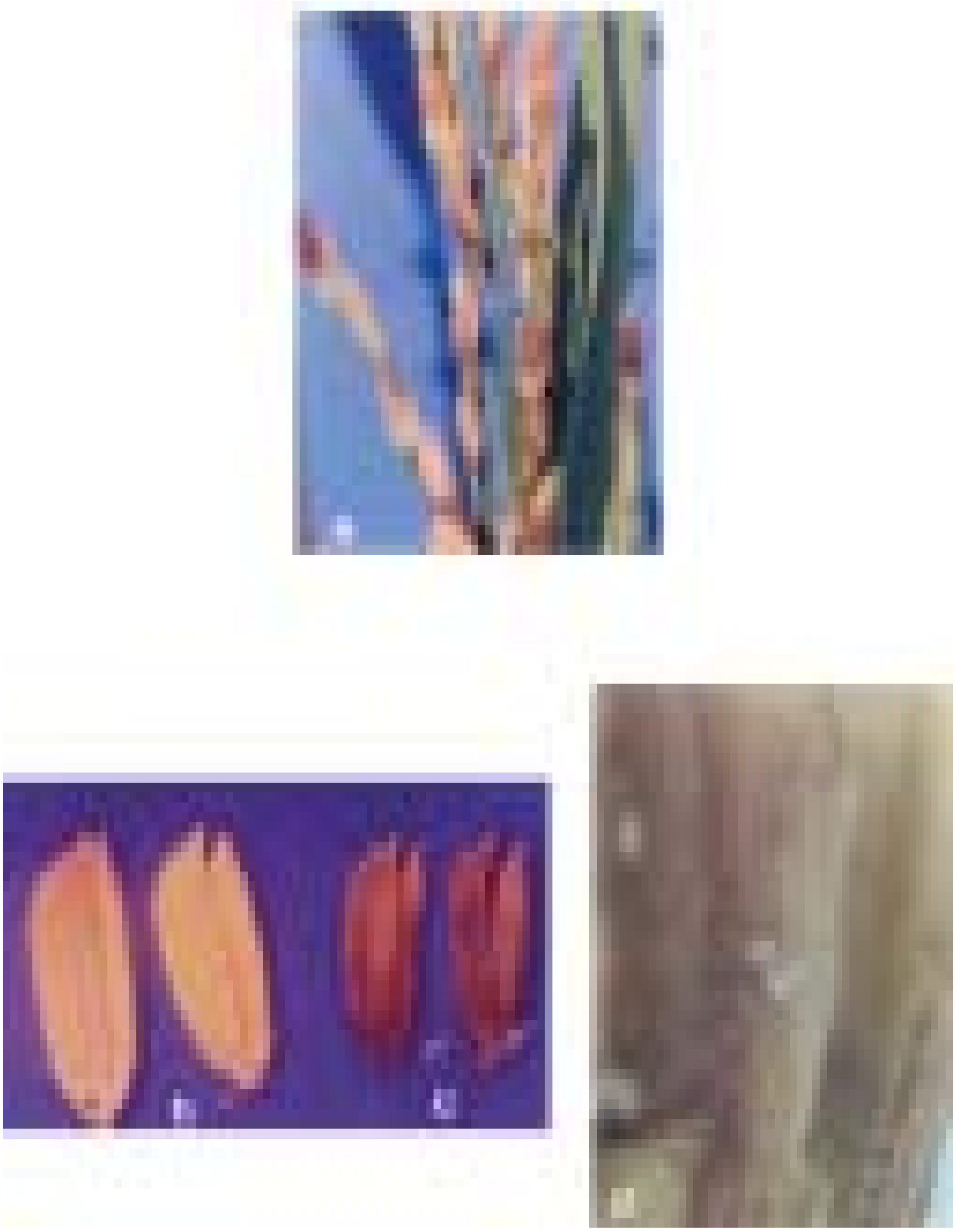

Plate 3

a. Grains in a panicle damaged by *Steneotarsonemus spinki*
b. Chaffy grains without discolouration of glumes
c. Chaffy grains with discolouration of glumes
d. *Steneotarsonemus spinki* feeding inside the developing grains

b) Summer 2002

Location	*Varieties*	*Percentage of hills infested by mites*	*Leaf blade*		*Leaf sheath*		*Mean no. of mites per five grains*
			Mean length of necrotic spot (cm)	*Mean no. of mites*	*Mean length of discolouration (cm)*	*Mean no. of mites*	
Bangalore	Thulasi	-	38.0	0.7	0	0	0
	Jaya	-	36.5	0.8	0	0	0
	IET 16364	-	10.5	0.7	0	0	0
	Kirwana	-	31.5	0.7	13.8	11.8	0
	Rasi	-	32.2	0.7	0	0	0
Siruguppa (Bellary)	Erramallelu	10	18.8	0.4	0	0	0.4
	Tellahamsa	12	26.4	0.6	0	0	0.2
	Sasyasree	14	15.8	0.6	0	0	0
	Ratnasagara	30	29.2	0.5	0	0	0.3
	Aditya	46	24.4	0.6	0	0	0.8
Brahmavara (Dakshina Kannada)	Jaya	44	17.4	0.5	12.6	5.6	0.5
	KCP 1	62	31.2	0.6	14.6	10.0	0.3
Kapu (Dakshina Kannada)	BR 2655	34	28.0	0.4	13.2	10.6	0.4
	MO 4	54	23.9	0.1	6.6	12.8	0.2
Mandya	KRH 2	30	48.4	0.8	12.0	7.2	0.8
	BR 2655	22	31.4	0.7	30.6	7.0	1.1
Manvi (Raichur)	Sonamasuri	34	18.6	0.7	0	0	0.4
	Sujatha	12	21.0	0.6	0	0	0.3
Honnaville (Shimoga)	Basumathi	12	3.8	0.4	0	0	0.3
	Hemavathi	14	10.0	0.5	0	0	0.4
	IR 64	34	35.4	0.6	5.6	4.8	0.3
	Jyothi	38	52.2	0.7	3.6	5.6	0.5
	Emergency sona	46	24.2	0.6	0	2.6	0.3
	Shikaripura local	58	84.5	0.7	18.4	5.6	0.7
	Faro	62	94.8	0.6	7.8	9.4	0.7
	BR 2655	40	23.8	0.6	0	0	0.4
	Rasi	54	60.2	0.7	2.2	4.2	0.5
	MTU 1001	58	68.0	0.6	4.8	7.8	0.5

Seasonal incidence

In Taiwan, peak population of *S. spinki* was observed from heading to milky grain stage and the mite population was negatively correlated with rainfall and positively correlated with sunshine period (Chen *et al.,* 1979). Low rainfall and high humidity influenced the occurrence of this mite, while temperature showed negative correlation with population of the mite (Feng, 1980).

Steneotarsonemus spinki was found to infest rice plants throughout the year in Cuttack region of Orissa in India. Incidence was high during November and low during February. Population was highest at the booting stage and declined further with the maturity of the crop (Ghosh *et al.,* 1997). Low rainfall and more sunshine were favourable for mite multiplication under field conditions. Mite population peaked at milky grain stage and thus disrupted the development of grains (Ghosh *et al.,* 1999).

Prabhakara (2002) studied the seasonal incidence of the mite during kharif 2001 at the Main Research Station, Hebbal, Bangalore on HR-12, IR-36, IR-64, Morro, and Mukthi varieties and during summer 2002 at VC Farm, Mandya on varieties, BR-2655 and KRH-2. The percentage of hills infested by mites during kharif showed gradual increase from 80 days after planting reaching a peak of 43 to 52 per cent between 100 and 120 days after planting. Gradual increase in the population of the mite was found with increase in the length of brown discolouration on leaf sheath (with a mite population of 12.9 to 23.3 mites per discoloured leaf sheath) between 100 and 120 days after planting. Presence of mites inside the spikelets was noticed from heading stage (110 days after planting) and mean number of mites in every five developing spikelets showing the symptoms of chaffyness (with or without discolouration of glumes) ranged from 0.2 to 0.8 mites (eggs+other stages) (Table 2). During summer the mite infestation was apparent from 90 days after planting on leaf blade or sheath and maximum infestation of hills observed was 42 per cent. Mites were abundantly seen on leaf sheath (22.1 mites) and panicle (1.0 mite/5 grains) at heading stage of the crop *i.e.* between 100 and 120 days after planting, similar to the observations during kharif (Table 2). At the time of harvest during kharif the percentages of chaffy grains without discolouration, chaffy grains with discolouration and filled but discoloured grains (partially or completely) from mite infested plants ranged from 1.00 to 3.1%, 11.5 to 24.7% and 2.1 to 13.7%, respectively. The corresponding percentages during summer were 2.6 to 4.0%, 2.6 to 16.0% and 4.6 to 8.9% (Table 3).

Ghosh *et al.* (1996) noticed occurrence of the tarsonemid mites, *S. spinki* and *Tarsonemus cuttacki* Iswari, on almost all the rice varieties grown under rainfed upland, irrigated medium land and rainfed low land conditions during rabi and kharif seasons.

Population of *S. spinki* dominated over that of *T. cuttacki.* Mite incidence was more during kharif than rabi and scented varieties harboured more number of mites than the non-scented varieties.

Life history parameters of tarsonemid mites associated with rice

Lindquist (1986) described characters to determine sex in the larval stage of a tarsonemid. Larval males generally differed from larval females in having three rather than two pairs of small pseudoanal setae flanking the uropore. The sex-linked difference in larva correlates with a similar difference in the adults. Females retain only one pair of setae, while males retain the two pairs, but are modified into accessory copulatory structure. The larvae are physically active and derive energy from the fat reserves for development to adulthood (Lindquist, 1969). Without moulting all the tarsonemid larvae enter an active, turgid stage before hatching to adults and this stage has been referred to as pupa or quiescent nymphal or quiescent larval stage (Suski, 1972). The presence of pharate nymphs is a highly specialized modification and characteristic of the basic life history in the Tarsonemina as a whole (Ewing, 1922). In species of *Steneotarsonemus,* males were found to be relatively common, in random samples of a laboratory population of *S. spinki* feeding on rice plants male to female sex ratio of 1:1 to 1:8 has been recorded (Lo and Ho, 1979 ; Chow *et al.,* 1980).

Steneotarsonemus spinki required 17, 4 and 2.75 days to complete its development from egg to adult stage at 25°C, 28°C and 30°C, respectively. At 25- 28°C, the adult female and male, respectively lived for 15±1.0 days and 7.6± 0.4 days, while both sexes lived for only 5 days at 30° C (Chen *et al.*, 1979). The females were facultatively parthenogenetic. Virgin females through arrhenotokous parthenogenesis produced only male progeny that could fertilize their mother and produce both males and females (Sogawa, 1977 ; Liang, 1984). When development of *S. spinki* was studied at 24.42° C and 70.47 per cent humidity on rice leaf sheath, it required an average of 7.77 days with a total developmental period of 5.75 to 9.64 days (Ramos and Rodriguez*,* 2000).

Another species of tarsonemid, *Tarsonemus cuttacki* Iswari feeding on fungus *F. moniliformae* completed egg-to-egg life cycle in 5-7 days at 28-30°C. Longevity of male and female mites was 9.5 and 15.5 days, respectively, the male to female ratio was 1:4 (Ghosh *et al.,* 1993). Life table analysis of this mite on fungal diet under laboratory conditions revealed that the intrinsic rate of natural increase was 13.05 times with a mean generation time of 10.85 days, the finite rate of increase was 1.26 (Ghosh *et al.,* 1995).

Table 2. Seasonal incidence of tarsonemid mite, *Steneotarsonemus spinki* on rice in Karnataka

Kharif 2001					*Summer 2002*			
Days after planting	*Per cent hills infested by mites*	** Mean no. of mites on leaf blade*	***Mean no. of mites on leaf sheath*	*Mean no. of mites in 5 spikelets*	*Per cent hills infested by mites*	** Mean no. of mites on leaf blade*	*** Mean no. of mites on leaf sheath*	*Mean no. of mites in 5 spikelets*
30	0	0	0	-	0	0	0	
40	0	0	0	-	0	0	0	0
50	0	0	0	-	0	0	0	0
60	0	0	0	-	0	0	0	0
70	0	0	0	-	0	0	0	0
80	22	21.8	0	0	0	0	0	0
90	30	24.9	0	0	29	8.5	0	0.3
100	52	32.9	12.9	0	42	21.0	3.5	0.7
110	52	42.9	21.9	0.2	34	37.8	9.4	0.8
120	43	42.5	23.3	0.4	36	34.9	22.1	1.0
130	35	23.5	14.6	0.8	41	17.3	5.1	0.3

**** per necrotic lesion on the leaf blade***
***** per discoloured leaf sheath***

Table 3. Incidence of tarsonemid mite *Steneotarsonemus spinki* on rice at Bangalore and Mandya and its effect on the grains

Grain characteristics	*Kharif 2001*		*Summer 2002*	
	Range	*Mean*	*Range*	*Mean*
Chaffyness without discolouration (%)	1 - 3.1	1.9	2.6 - 4.0	3.3
Chaffyness with discolouration (%)	11.5 -24.7	18.8	2.6 - 16.0	9.3
Per cent chaffyness	1- 24.7	20.7	2.6- 16.0	12.6
Filled discoloured grains (%)	2.1 - 13.7	9.7	4.6 - 8.9	6.7
Healthy grains (%)	60.1 - 85.4	69.6	72.6 - 88.8	80.7

Natural enemies

A phytoseiid mite, *Amblyseius fallacis* Garman was observed to feed actively on the colonies of *S. madecassus* (Gutierrez, 1967). Several phytoseiids and acarid mites have been reported to prey upon *S. spinki* and *S. furcatus* throughout the year (Lo and Ho, 1979a). *A. taiwanicus* and *Lasioseius parberlesei* Bhattacharya have been investigated for their potential in the control of tarsonemid mites (Lo *et al.,* 1979 ; Chow and Liu, 1984).

Spores of an unidentified microorganism infected the leaf lamina and killed the eggs, larvae and adults of *S. spinki* in Taiwan. The pathogen formed thick walled oocytes on the body cavities of female and male adult mites. The maximum infection (60ñ70%) occurred between mid September and mid October (Lo and Ho, 1979).

Dispersal and survival

Generally dispersal of tarsonemid mites is effected by direct mobility of adult fertilised females or by means of wind. Within the spatial limits of one host plant adult males aid in dispersal to new leaf by carrying pharate females (Gadd, 1946 ; Taksdal, 1973).

During the off-season, *S. spinki* survives on the rice stubbles and ratoon crops (Gutierrez, 1967 ; Lo and Ho, 1977 ; Chen *et al.,* 1979 and 1980 ; Rao and Prakash, 1995). After the harvest of the main crop mites move over to stubbles (7.6 to 36.7 mites/stubble) and later to ratoon crops (22.4 to 120.0 mites/tiller) (Ghosh *et al.,* 1996). The mites were observed on the leaf sheath of stubbles (of rice varieties HR 12, IR 36, IR 64, Morro and Mukthi) upto 2 months and the symptoms of damage were also conspicuous, such surviving mite populations might get carried over to the subsequent rice crops (Prabhakara, 2002).

A grass weed, *Cyanodon dactylon* (L.) Pers. (Graminae) was found as a reproductive host of *S. spinki*. The eggs, larvae and adults of this mite were recovered from both infested and healthy plants. The mite population ranged from 11 to 58 live mites/10 cm plant length (Rao and Prakash, 1996).

Association with fungi and other organisms

Tarsonemid mites caused considerable damage and deterioration in seed quality either by direct feeding on the plant tissues or by paving way for infection by microbes like fungi or bacteria (Lindquist, 1972 ; White and Sinha, 1981).

Inoculation of rice plants with *S. spinki* carrying the conidia of fungus *Acrocylindrium* (=*Sarocladium*) *oryzae* resulted in sheath rot disease and brownish spots on leaf sheath and grains (Hsieh *et al.,* 1977 and 1980). Conidia of the sheath rot fungus (*Sarocladium oryzae*) were observed on the body of *S. spinki*. Rice plants inoculated with both mite and fungus were heavily infected than the plants inoculated with either the mite or the fungus only (Chien, 1980). According to Feng (1980) the mite infestation caused sterility in rice plants and also aided the spread of the fungus. The fungus merely caused grain discolouration and browning of leaf sheath, but did not cause grain sterility. Role of the mite *S. spinki* and fungi *S. oryzae* and *Curvularia lunata* in causing deterioration of seed quality was studied by inoculating the mite and pathogens alone and also in different combinations. Seed discolouration was enhanced in combinations with *S. spinki* than with either of the fungi alone (Rao and Prakash, 1996a).

Chaffy grains and filled grains showing discolouration on the glumes collected from mite infested plants harboured several species of fungi namely, *Alternaria* sp*., Aspergillus* sp*., Cladosporium* sp*., Curvularia* sp*., Fusarium moniliformae, Fusarium* sp., *Helmithosporium* sp*.,* and *Pencillium* sp*.,* and these fungi along with the mites might cause discolouration of the grains (Prabhakara, 2002).

Infection of sheath rot fungus along with the infestation of *S. spinki* and nematodes produced ugly looking panicles and such panicles with severely discoloured grains were called ëdirty paniclesí (Rao *et al*., 1993). However, Rao *et al*. (2000) reported that the mite *S. spinki* was dominant in all the cases and the associated white tip nematode was identified as *Aphelenchoides besseyi*. *Tarsonemus talpae* has been reported by Mingguang *et al.* (1984) and Li *et al.* (1986) to transmit brown sheath rot disease in rice caused by *Acrocylindrium oryzae*.

Control of tarsonemid mites on rice crop

Lo and Ho (1977) and 1979 opined that acaricide treatment of paddy stubbles would prevent the mite outbreak in the succeeding crops and they advocated the destruction of ratoons and rice stubbles and keeping rice fields fallow for at least 2 weeks after the harvest of the crop to minimize the damage due to the mite. Feng (1980) found ethylparathion foliar spray as very effective against *S. spinki* and symptoms of sterility disease were not recorded from treated plots. Parathion and dicofol were highly effective in reducing the population of *S. spinki* upto 97% and it also minimized grain sterility upto 7.3% as compared to 72% sterility observed in untreated control (Lo *et al.,* 1981). Ghosh *et al.* (1998), who studied the effectiveness of pesticidal treatments against *S. spinki* on Ratna rice variety found that dimethoate (0.04%) as foliar spray during active tillering stage was most effective in reducing both mite population by 88.49% and grain deterioration by 18.63%, while dicofol application resulted in poor control of the mite.

Treatment schedule inclusive of application of dicofol (0.05%) between 75 and 90 days after planting significantly reduced the extent of mite infestation as well as mite population (on leaf blade and panicle) for 15ñ20 days and the proportion of ill filled or chaffy grains was also significantly low (Prabhakar, 2002). No definite relationship between the application of fungicides, hexaconazole and carbendazim, as twoñfive applications at 40, 50, 70, 80 and 100 days after planting and the percentage of hills infested by mites as well as the abundance of mites (on leaf blade, leaf sheath, and panicle) was evident, but the proportion of chaffy or filled grains showing discolouration of glumes was relatively low in plots treated with fungicides compared to untreated plots (Prabhakara, 2002).

Since the tarsonemid mite, *Steneotarsonemus spinki* is wide spread in Orissa, Karnataka and Andhra Pradesh causing extensive damage to leaves and panicles of the rice crop, inclusion of an acaricidal treatment at the heading stage of the crop and proper destruction of mite infested rice stubbles are recommended for effective management of the mite for better yields and to minimize its spread or carry over to the successive crops.

References

ANONYMOUS, 1997-98. *Annual Report,* Department of Agricultural Research and Education / Indian council of Agricultural Research, New Delhi, 80-81pp.

ANONYMOUS, 1999-2000. *Annual Report,* Department of Agricultural Research and Education/Indian council of Agricultural Research, New Delhi, 40pp.

ANONYMOUS, 2000-01. Highlights of Research, PC Unit, AICRP (Agril. Acarology), University of Agril. Sciences, Bangalore, 2pp.

CHEN, C.N., CHENG, C.C. and HSIAO, K.C., 1979. Bionomics of *Steneotarsonemus spinki* Smiley attacking rice plants in Taiwan. *Recent. Adv. Acarol.,* **1** : 111-117.

CHEN, C.N., CHENG, C.C., SU, W.Y. and HO, K.Y., 1980. Bionomics of the rice tarsonemid mite and its relation to rice sterile grain syndrome. A Review. *Plant Prot. Bull. Taiwan* (R.O.C), **22** : 63-82.

CHIEN, C.C., 1980. Studies on the sheath rot disease and its relation to the sterility of rice plants. *Plant. Prot. Bull. (Taiwan)*, **22** : 31-39.

CHO-MYOUNG RAE, KIM ñ DEOGSU, IM ñ DAEJOON, NA ñ SEUNGYONG, YIEM-MYOUNGSOON, CHO ñ MR, KIM ñ DS, IM-DJ, NA-SY, and YIEM-MS, 1999. A new record of tarsonemid mite, *Steneotarsonemus spinki* Smiley (Acari: Tarsonemidae) and its damage on rice in Korea. *Korean J. Applied Entomol.,* **38** : 157-164.

CHOW, Y.S. and LIU, M.A., 1984. Preliminary studies on a parasite and a predatory mite of the tarsonemid mite *Steneotarsonemus spinki* Smiley. In : Griffiths, D.A and Bowman, C.F (Eds), *Acarology VI (Proc. 6th Intn. Cong. Acarol. Edinburgh, Scotland, 1982)* Vol. 1, Ellins Horwood, Chichester, England, 327pp.

CHOW, Y.S., TZEAN, S.S., CHANG, C.S. and WANG, C.H., 1980. A Morphological approach to study the tarsonemid mite, *Steneotarsonemus spinki* Smiley (Tarsonemidae) as a rice plant pest. *Acta Acarchno.*, **29** : 25-41.

EMMANOUEL, H.G., 1981. A new species of the mite from family Tarsonemidae (Prostigmata), pest of the wheat in Greece. *Intl. J. Acar.,* **7**: 179-182.

EWING, H.E., 1922. Studies on the taxonomy and biology of the tarsonemid mite, together with a note on the transformation of *Acaropsis* (*Tarsonemus*) *woodi* Rennie (Acarina). *Can. Ent*., **54** : 104-113.

FENG, H.C., 1980. Etiological studies on the sterility of rice plant and its control. *Plant Prot. Bull., Taiwan* (R.O.C), **22** : 83-89.

GADD, C.H., 1946. Observations on the yellow tea mite *Hemitarsonemus latus* (Banks) Ewing. *Bull. Ent. Res.,* **37** : 157-162.

GHOSH, S.K., PRAKASH, A. and RAO, J., 1998. Efficacy of some chemical pesticides against rice tarsonemid mite *Steneotarsonemus spinki* smiley (Acari: Tarsonemidae) under controlled conditions. *Environ. Ecol.*, **16** : 913-915.

GHOSH, S.K., RAO, J., DHANASHEKARAN, S. and PRAKASH, A., 1993. Biology of rice tarsonemid mite, *Tarsonemus cuttacki* Iswari under controlled conditions. *J. Appl. Zool. Res*., **4** : 133-135.

GHOSH, S.K., RAO, J. and PRAKASH, A., 1996. Incidences of tarsonemid mites in rice fields during crop and off-seasons. *J. Appl. Zool. Res.,* **7** : 160.

GHOSH, S.K., RAO, J. and PRAKASH, A., 1997. Population fluctuation of rice tarsonemid mite, *Steneotarsonemus spinki* Smiley (Acari : Tarsonemidae) in the rice ecosystems. *Entomon*, **22** : 105-109.

GHOSH, S.K., RAO, J. and PRAKASH, A., 1999. Off-season inhabitation of rice tarsonemid mite, *Steneotarsonemus spinki* Smiley and *Tarsonemus cuttacki* Iswari (Acari : Tarsonemidae) in the rice ecosystems. *Annals Pl. Prot. Sci.,* **7** (In press).

GHOSH, S.K., RAO, J., PRAKASH, A. and SINHA, S.K., 1995. Age specific fecundity, life table and intrinsic rate of increase of rice tarsonemid mite, *Tarsonemus cuttacki* Iswari (Acari : Tarsonemidae) under controlled conditions. *Oryza,* **32** : 98-100.

GOTO, M., ZEIGLER and JOHN, V.T., 1987. Progress in seed health research on seed borne and contaminant bacteria, viruses and nematodes. *Intl. workshop on Rice Seed Health*, 16-20 March 1987, IRRI, Manila, Philippines, 49.

GUTIERREZ, J., 1967. *Steneotarsonemus madecassus* n. sp. Agent 1í une deformation des panicle de je siezea Madagascar (Acarina: Tarsonemidae). *Bull. Ent. Soc. France*, **72** : 323-333.

HSIEH, S.P.Y., LIANG, W.L. and CHANG, S.Y., 1977. Etiological studies on the sterility of rice plant, association of sheath rot fungus with sterile rice plant. *Plant Prot. Bull. (Taiwan),* **19** : 30-36.

HSIEH, S.P.Y., SHUE, M.F. and LIANG, W.J., 1980. Etiological studies on the sterility of rice plant II. Transmission and survival of *Acrocylindrium oryzae* Swada, fungus associated with sterile rice plant. *Plant Prot. Bull. (Taiwan),* **22** : 41-46.

LI, L.S., FENG, M.G. and HU, G.W., 1986. Studies on feeding habitats of *Tarsonemus talpae* Scharr-Schmidt. *Insect Knowledge*, **28** : 6-9.

LIANG, W.J., 1984. Etiology of rice sterile disease and reproduction ability of parthenogenetic male progenies of the rice tarsonemid mite, *Steneotarsonemus spinki* Smiley. *Taiwan Agril. Res. Inst. Special Publ.,* **16** : 223-228.

LINDQUIST, E.E., 1969. Review of holarctic tarsonemid mites (Acarina : Prostigmata) parasitizing eggs of ipae bark beetles. *Mem. Ent. Soc. Can.*, **60** : 111.

LINDQUIST, E.E., 1972. A new species of *Tarsonemus* from stored grain (Acarina: Tarsonemidae). *Can. Ent.*, **104** : 1699-1708.

LINDQUIST, E.E, 1986, A means of determining sex in larval Tarsonemidae (Acari: Heterostigmata) based on external structures. *Exptl. Appl. Acarol.*, **2** : 323-8.

LO, K.C. and HO, C.C., 1977. Preliminary studies on rice tarsonemid mite *Steneotarsonemus spinki* Smiley (Acarina : Tarsonemidae). *Nat. Sci. Coun. Monthly,* **5** : 274-284.

LO, K.C. and HO, C.C., 1979. Studies on the cause of empty head of rice in Taiwan. *J. Agric. Res. China,* **28** : 193-197.

LO, K.C. and HO, C.C., 1979a. Ecological observations on rice tarsonemid mite, *Steneotarsonemus spinki* Smiley (Acarina : Tarsonemidae). *J. Agric. Res. China*, **28** : 181-192.

LO, K.C., HO, C.C., and CHEN, S.T., 1979. Artificial propagation of *Amblyseius taiwanicus* and its tolerance to some pesticides. *J.Agric.Res.China,* **28** : 251-259.

LO, K.C., HO, C.C. and LIS , K.C., 1981. Screening of chemicals for the control of rice tarsonemid mite, *Steneotarsonemus spinki* Smiley. *J.Agric.Res.China*, **30** : 303-7.

MATHUR, K.C., REDDY, P.R., RAJAMANI, S. and MOORTHY, B.T.S., 1999. Integrated pest management in rice to improve productivity and sustainability. *Oryza*, **36** : 195-207.

MINGGUANG, F., LUNGSHU, L., GENSHENG, B. and GUOWEN, H., 1984. Studies on the rice tarsonemid mite (*Tarsonemus talpae*) in relation to the rice sheath brown syndrome. *J. South-west Agril. Coll.*, **3** : 165-174.

OU, Y.T., PANG, H.C. and TSENG, Y.H., 1977. Studies on *Steneotarsonemus madecasus* Gutierrez on rice. *Plant Prot. Bull. (Taiwan),* **19** : 21-29.

PRABHAKARA, H. 2002. *Investigations on Steneotarsonemus spinki Smiley (Acari : Tarsonemidae) infesting rice crop (Oryza sativa L.).* M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Bangalore, 137p.

PRAKASH, A. and KAURAV, L.P., 1982. Studies on insects, mites, and fungal infestation in rural and farm stored rice in Orissa. *J. Res. Assam. Agric. Univ.,* **3** : 190-196.

RAMOS, M. and RODRIGUEZ, H., 1998. *Steneotarsonemus spinki* Smiley (Acari : Tarsonemidae): New report for Cuba. *Revistañde-proteccionñvegetal.*, **13** : 25-28.

RAMOS, M., and RODRIGUEZ, H., 2000. Developmental time of *Steneotarsonemus spinki* Smiley (Acari : Tarsonemidae) in laboratory. *Revista- de- Proteccion- vegetal.,* **15** : 130-131.

RAO, Y.S. and DAS, P.K., 1977. A new mite pest of rice in India. *Intl. Rice. Res. Newsl.*, **2** : 8.

RAO, J. and PRAKASH, A., 1992. Infestation of tarsonemid mite *Steneotarsonemus spinki* Smiley in Rice in Orissa. *J. Appl. Zool. Res*., **3** : 103.

RAO, J. and PRAKASH, A., 1995. Bio-deterioration of paddy seed quality due to insects and mites and its control using botanicals. *Final Report of ICAR Ad-hoc Scheme* (1992-1995), CRRI, Cuttack (India), 76pp.

RAO, J. and PRAKASH, A., 1996. *Cyanodon dactylon* (Linn.) Pers. (Graminae), an alternate host of rice tarsonemid mite *Steneotarsonemus spinki* Smiley. *J. Appl. Zool. Res*., **7** : 50-51.

RAO, J. and PRAKASH, A., 1996a, Interactions of rice tarsonemid mite *Steneotarsonemus spinki* Smiley with rice pathogenic fungi to deteriorate paddy seed quality. *J. Appl. Zool. Res.,* **7** : 165-166.

RAO, J., PRAKASH, A., DHANASEKHARAN, S. and GHOSH, S.K., 1993. Observation on tarsonemid mite, white tip nematode and sheath rot fungus interactions deteriorating grain quality in the paddy fields. *J. Appl. Zool. Res.,* **4** : 89-90.

RAO, P.R.M., BHAVANI, B., RAO, T.R.M. and REDDY, P.R., 2000. Spikelet sterility/grain discolouration in rice in Andhra Pradesh, India. *Intl. Rice Res. Notes*, **25** : 40.

RUBIA, E.G. and SHEPHARD, B.M., 1988. A rearing technique for *Conocephalus longipennis* De Honn. (Orthoptera : Tettigonidae). *Intl. Rice. Res. Newsl*., **13** : 32-33.

SOGAWA, K., 1977. Occurrence of the rice tarsonenmid mite at IRRI. *Intl. Rice. Res. Newsl.,* **2** : 17.

SUSKI, Z.W., 1972. Tarsonemid mites on apple trees in Poland X-Laboratory studies on the biology of certain mite species of the family Tarsonemidae (Acarina: Heterostigmata). *Zesz. Probl. Post. Nauk Roln.,* **129** : 111-137.

TAKSDAL, G., 1973. Interactions between pest and host plant in attack by the broad mite, *Hemitarsonemus latus* (Banks) (Acarina : Tarsonemidae) on passion fruit, *Passiflora edulis* Sims. *Norsk. Ent. Tidsskr*., **20** : 301-304.

TSENG, Y.H. and LO, P.K.C., 1980. Tarsonemid mites (Acarina: Prostigmata) from Taiwan. *Plant Prot. Bull., Taiwan* (R. O. C.), **20** : 113-140.

WHITE, N.D.G. and SINHA, R.N., 1981. Life history and population dynamics of the mycophagous mite, *Tarsonemus granarius* Lindquist (Acari : Tarsonemidae). *Acarologia*, **22** : 353-360.

ZHANG, B.D., 1984. Preliminary observations on the biological characteristics of *Steneotarsonemus spinki* Smiley. *Insect Knowledge,* **18** : 55-56.