Screening of Three Coconut Genotypes Tolerant to Coconut Mites *(Aceria guerreronis)* in Ambakelle Isolated Seed Garden in Sri Lanka.

H.J.M. KUSUMASENA[1], I.R. WICKRAMANANDA[2] and M.N.D. FERNANDOPULLE[1]

[1]*Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), Sri Lanka.*

[2]*Crop Protection Division, Coconut Research Institute of Sri Lanka, Bandirippuwa Estate, Lunuwila, Sri Lanka.*

ABSTRACT

Coconut is one of the major plantation crops and it contributes to a larger proportion to domestic consumption. Coconut mite (*Aceria guerreronis*) is a newly identified pest which severely damages the immature nuts of the coconut palms. Three main coconut varieties are grown in Sri Lanka, *viz.* Nana, Typica and Aurantica. They include various forms that are tolerant to coconut mite. The study was carried out to identify the tolerant forms or varieties and their tolerant level against the coconut mite. The study was conducted in Ambakelle isolated seed garden using forms of Sri Lankan Dwarf Yellow, Sri Lankan Dwarf Green and Ambakelle Special parental blocks. Methods used to collect the necessary data were population assessment of mites in immature nuts, crop loss estimation at the harvest and damage initiation in 4th and 5th bunches. Ten palms from both Sri Lankan Dwarf Yellow and Ambakelle Special were screened to take population assessment of mite in immature nuts and damage initiation of 4th and 5th bunches. Hundred palms from each form were screened to obtain the crop loss estimation at harvesting. Results revealed that Sri Lankan Dwarf Yellow had a higher tolerance against the *Aceria guerreronis* over Sri Lankan Dwarf Green and Ambakalle Special. Lowest tolerance could be observed in Sri Lankan Dwarf Green. Therefore, the Sri Lankan Dwarf Yellow form can be utilized to breed mite tolerant progenies in future.

KEY WORDS: Coconut, Varieties, Forms, *Aceria guerreronis*, Tolerance, Wash count, Crop Loss Estimation

INTRODUCTION

Coconut (*Cocos nucifera L.)* is a perennial tree crop well adapted to the hot and humid conditions of the tropics which is widely grown in Sri Lanka. It is a plantation crop which occupies about 440,000 ha corresponding to nearly 6.4% of the total cultivable land extent (Fernando *et al.*, 2000). Most widely, it is grown along the coastal belt, in parts of dry zone and parts of the wet zone. It does not properly grow in high mountainous areas.

The first occurrence of coconut mite (*Aceria guerreronis* K.) was reported in 1965 from the state of Guerrero in Mexico (Keifer, 1965). Since then, this coconut mite was reported from several countries in Africa, South and Central America and Caribbean Islands. It is a noxious pest in the Caribbean Islands, Africa and America where it caused an estimated loss up to 25% in yield of copra (Mariu, 1977). Coconut mite is believed to be an introduced pest to Sri Lanka. It was first reported in Kalpitiya peninsula in late 1997(Fernando *et al.*, 2000). Currently it is occurring in Northern, North Central, Western and Eastern provinces and Gampaha, Matale and Hambantota districts.

The adult of this mite has an elongated and worm like body. They are minute and measure about 200-250 μ in length and 40 μ in width. They have two pairs of legs in the anterior portion of the body. A female lays 20 to 100 eggs. The life cycle is completed within 7-10 days. Large numbers of coconut mites colonize on the tender portion of nut (button) covered by inner bract of the perianth and suck the sap from meristamatic tissues. As the feeding sites grow out of the perianth, they appear as white or creamy triangular bands or patches. These patches turn in to yellow and become brown and then develop fissures and finally appear as warts. Due to the drying tissues of coconut, the enlargement of the nut is affected and it leads to a drastic reduction in the size of the nut. When the infestation is high in the early stages of development, the button shedding is also heavy. Because of the hampered growth of affected nuts, the kernel size and quality are affected.

The mites attack one to three month old immature nuts usually after pollination. However, the unfertilized female flowers do not harbor the mites. The pest is dispersed through wind to long distance and within the plantation it is spread by phoresis and rain. Some studies have revealed that the mites could migrate by walking in large numbers across nut surfaces and they could move from one inflorescence to another, if the two are in contact. Severe nut damage appears to encourage mite dispersal.

This newly identified pest has severely affected the coconut plantation sector in Sri Lanka and it leads to a drastic reduction of the crop. It has been observed that there is a varietal difference in the severity of mite damage. Therefore, it is assumed that this varietal effect for the mite damage is due to the genetic and physiological condition of the varieties.

A critical examination of data pertaining to the morphological characters and breeding systems of coconut palms grown in Sri Lanka indicated that three varieties could be distinguished. They are Typica, Nana and Aurantica. Variety Typica (SLT) is the popular Sri Lankan palm grown on a plantation scale. Flowering occurs 5 to 6 years after planting. Flower production is continuous and predominantly out breeding. These are hardy palms tolerating a wide range of environmental conditions. Large numbers of forms are classified under variety Typica such as Navasi, Ranthembili, Porapol, Bodiri, Kamandala and Deekiripol. Variety-Nana consists of Pumila, Eburnea and Regia forms. They have been used extensively in

breeding works, because of low stature and large number of nuts as well as early flowering. Thus, flowering occurs within 3 to 4 years after planting. They do not bear root bole. Forms of the Nana variety are susceptible to pests, diseases and drought. They are self pollinating and have 40 years of economic lifespan. Variety-Aurantica is also late flowering and it takes 5 to 6 years. The flower production is seasonal. Aurantica favours inbreeding. The epicarp of the nut is orange in color. Aurantica suffers from drought as well as susceptible to pest and diseases. Forms of the variety-Aurantica are king coconut (Thembili) and Nawasi thembili. King coconut has nut water with higher sucrose content. They are grown on a large scale for drinking purposes.

This study was carried out to screen the mite tolerance of Sri Lankan Dwarf Yellow, Sri Lankan Dwarf Green and Ambakelle Special, to distinguish the most tolerant form and to identify the prominent contributory factor for damage (small nuts, deformed nuts, barren nuts). Sri Lankan Dwarf Yellow, Sri Lankan Dwarf Green and Ambakelle Special were able to distinguish properly according to their morphological characters such as shape of the nuts, shape of the palms, shape of the crown, colour of the leaves and colour of the young nuts (Figure 1). In addition to that some genetic and physiological conditions can be used to separate the above three forms (Appendix 1). As an example, Sri Lankan Dwarf Yellow and Dwarf Green have yellowish and greenish colour epicarps, respectively. Colour of the epicarp may vary in the Ambakelle Special.

Various research efforts based on chemical, biological and integrated methods have been made to control the coconut mite in the world within past few decades. In addition to Monocrotophos, Dicofol, Carbosulfan, Triazophos and Endosulfan, botanically based low toxic chemicals such as Neemzal and Azadhiractin have also been used in different formulations to get rid of this severe problem. Natural enemies of arthropods are classified as pathogens, predators or parasitoids. In practice only pathogens and predators have been used in the biological control of pest mite. Among these *Neoseiulus paspalivorus* was identified as a predatory mite. Some studies were carried out to control the eriophyid mite using fungi known as *Hirsutella thompsonii.* However, none of these methods have been accepted as sustainable management practices of controlling coconut mite, as chemical methods require repeat applications within short term duration and biological control requires appropriate conditions such as temperature, relative humidity *etc.* As a result, it is essential to investigate the possibility of using tolerance of coconut forms against the coconut mite. This may be a sustainable management practice and a cost effective method of controlling the coconut mite.

MATERIALS AND METHODS

To identify the responses of coconut genotypes against eriophyid mite, the available coconut genotypes at isolated seed garden, Ambakelle, which was under natural infestation, were screened, from March to June 2005.

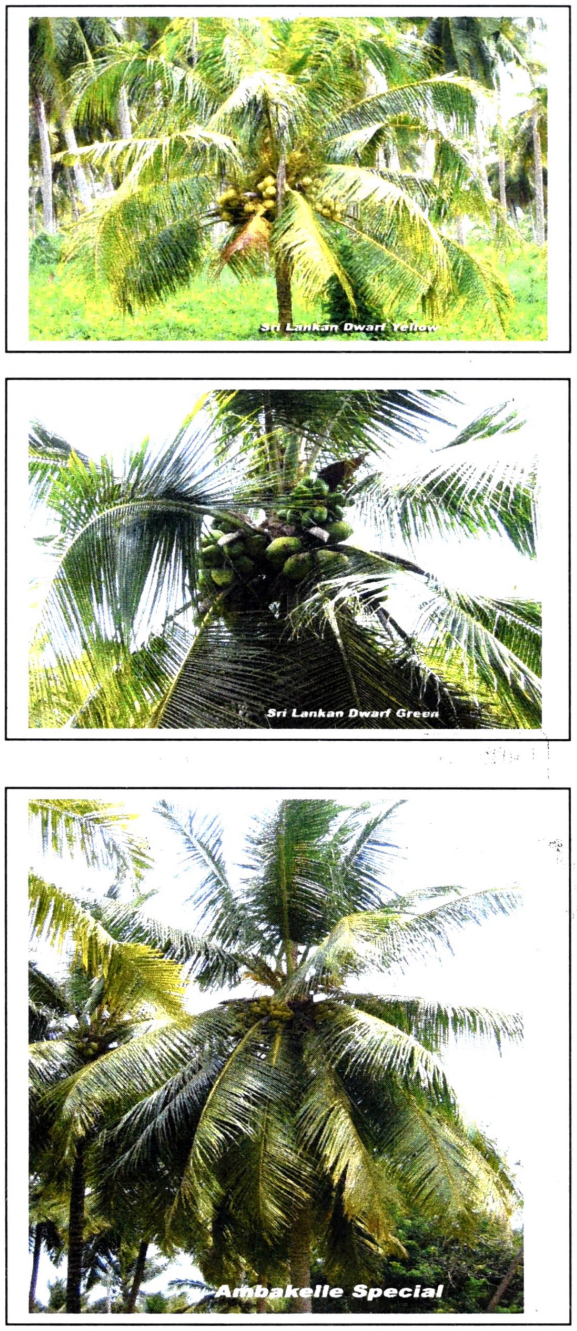

Figure 1. Three different coconut forms, Sri Lankan Dwarf Green, Sri Lankan Dwarf Yellow and Ambakelle Special.

Typica and Nana were two main coconut varieties in that seed garden. Sri Lankan Dwarf Yellow and Sri Lankan Dwarf Green were the two forms of the variety Nana and, Ambakelle Special was the available form of the variety Typica. The study was carried out in three selected fields, identified as 10A, 10B and 11A. Sri Lankan Dwarf Yellow and Sri Lankan Dwarf Green had been cultivated in 10A and 10B, respectively, and 11A consisted of Ambakelle Special. All the palms that were examined had been planted in 1985 and they were of the same age. In this study, the field conditions such as soil fertility and moisture content were assumed to be uniform in all fields. The other main assumption was that all palms were free from other pests and disease conditions. To

achieve the objectives of this study, three methods were used such as estimation of crop loss at the harvest, population assessment of mites in immature nuts and damage initiation assessment in 4th and 5th bunches.

Crop Loss Estimation at the Harvest

For this estimation, 100 palms were selected from each field. The data were collected during the harvest in June 2005. The nuts were categorized according to the following criteria introduced by Coconut Research Institute. The nuts from each palm were categorized based on the size in to two main categories named as large (S_1) and small (S_2). Then each of them was again subdivided in to two groups based on the presence (M_1) or absence (M_2) of mite damage. Thereafter, nuts with the presence of mites were subdivided in to three categories according to the shape of the nuts as normal (N) deform (D) and barren nuts (B) (Peiris *et al*, unpublished report 2005).

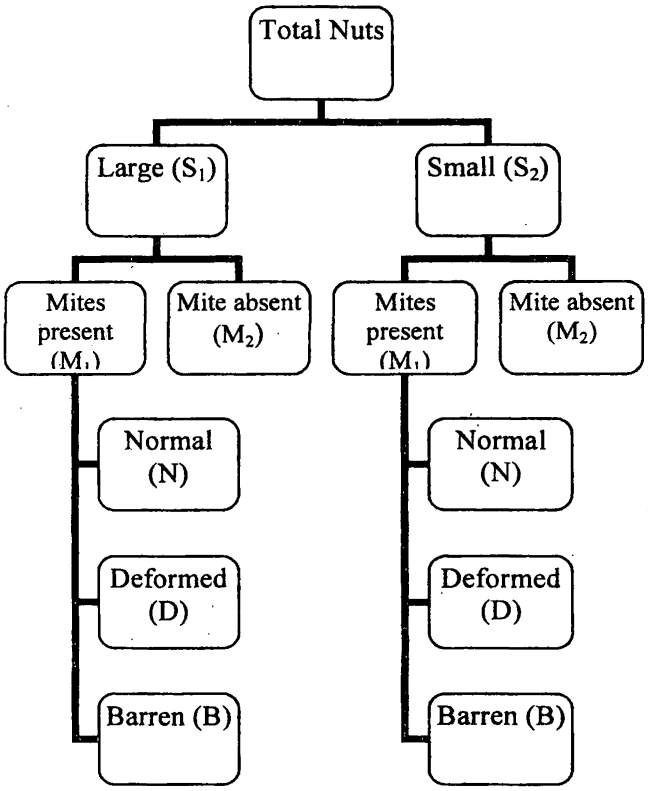

Figure 2. Key to estimate the crop loss due to mite damage (This was developed by CRI Sri Lanka).

Percentage Crop Loss Estimation $= 1/2S_2M_1N+S_2M_1D+ S_2M_1B+S_1M_1B$

$1/2S_2M_1N$= Mite damaged small nuts which are not deformed or barren.
S_2M_1D= Mite damaged small deformed nuts
S_2M_1B= Mite damaged small barren nuts
S_1M_1B= Mite damaged large barren nuts

Population Assessment of Mites in Immature Nuts

Ten palms from each form were selected for this experiment. However, it was unable to select any palms from Sri Lankan Dwarf Green as the palms had been treated with used engine oil and natural population level in nuts had been affected. One immature nut was picked from the fourth bunch of each of the selected palms. The total population of mites in each nut was estimated by wash count method described by Siriwardana (1999).

Wash Count Method

The perienth of the nut was removed and bracts and nut surface were washed using 30ml of Tween 80% solution. Then the solution was stirred for a few seconds. Thereafter 1ml of stirred solution was aliquot and placed on a Petri dish with 25 mm diameter and the number of mites was counted under the microscope.

RESULTS AND DISCUSSION

Crop Loss Estimation at the Harvest

The data were analyzed using SAS (1998). The results revealed that there was a significant impact of different forms on tolerance against *Aceria guerreronis*. The highest tolerance against coconut mite was observed in Sri Lankan Dwarf Yellow compared to Sri Lankan Dwarf Green and Ambakelle Special and the lowest crop loss estimation at the harvest was recorded in Sri Lankan Dwarf Yellow (7.32%).

Table 1. Mean crop loss estimation at the harvest in three different forms, Sri Lankan Dwarf Yellow, Sri Lankan Dwarf Green and Ambakelle Special.

Coconut Forms	Crop Loss Estimation at the harvest (%)
Dwarf Yellow	7.32 **c**
Dwarf Green	22.3 **a**
Ambakalle Special	13.7 **b**
LSD	4.3452
CV	18.788
R^2	0.872

The experiment conducted by Muthiah and Bhaskaran (1999) has clearly shown that genotype Seychelles all the nuts (100%) were completely damaged by the mites followed by St.Vincent (90.43%) and Nigerian Tall (87.54%). In addition to that Lakshadweep Ordinary (4.92%), Cochin China (10.41%), Andaman Ordinary (11.43%) and Gangabondam (12.67%) recorded minimum percentage of nuts damaged by the mites. They have recommended the above four varieties to develop the mite tolerant breeding material.

Population Assessment of the Immature Nuts

Only Dwarf Yellow and Ambakelle Special forms were assessed to obtain the data. The data were analyzed using t-test procedure. There was a significant difference in mite populations on the immature nuts among these two varieties ($P<0.05$).

Thus, one of these two forms may tolerant to coconut mite. Sri Lankan Dwarf Yellow was recorded low mean population of mites than Ambakelle Special. Thus Sri Lankan Dwarf Yellow has higher tolerance than Ambakelle Special.

Damage Initiation assessment of the 4th and 5th Bunches

Damage initiation of the 4th and 5th bunches were examined using the forms of Sri Lankan Dwarf Yellow and Ambakalle Special. Data were analyzed using the t-test Procedure. Probability value for initiation of damage symptoms in both 4th and 5th bunches revealed that there was no significant difference among those two forms (P>0.05).

Identification of Major Contributory Factor to Crop Loss.

Table 2. Relationship between three different coconut forms and contributory factors to their crop loss.

Factors Effect to Crop Loss	Forms		
	Sri Lankan Dwarf Yellow	Sri Lankan Dwarf Green	Ambakalle Special
$1/2S_1M_1N$	39.51	45.36	71.58
S_1M_1D	38.27	32.99	20.53
S_1M_1B	21.6	18.56	6.05
S_2M_1B	0.62	3.09	1.84

Table 3. Maximum Likelihood Analysis of Variance (Crop Loss*Varieties)

Source	DF	Chi sq	Probability Value
Crop Loss*Forms	6	67.93	<.0001
Likelihood Ratio	6	68.17	<.0001

Major contributory factor to crop loss was identified by using records which were taken from the crop loss estimation at the harvest. Data were analyzed using Chi-Square procedure. Results revealed that there can be observed relationship between varieties and contributory factors to crop loss. When considering the strength of the relationship, highest strength was recorded from the infested small nuts which were not deformed or barren with the all above three varieties. It was contributed in larger proportion to crop loss at the harvest. It was followed by the small nuts which were deformed and barren. In addition, there can be observed minimum crop loss from the mite with large barren nuts.

CONCLUSIONS

Among the three coconut genotypes screened, the genotype Sri Lankan Dwarf Yellow recorded minimum nut damage in response to *Aceria guerreronis* and could be utilized in breeding varieties for mite tolerance. The genotypes Sri Lankan Dwarf Green and Ambakelle Special were found to be susceptible to mite attack. Sri Lankan Dwarf Green was highly susceptible than Ambakelle Special. There was a great effect on crop loss from the infested small nuts. Further studies could be carried out to breed a new progeny using the tolerant parental material in future.

ACKNOWLEDGEMENTS

Authors are grateful to Prof. S.J.B.A. Jayasekara, Dean, Faculty of Agriculture and Plantation Management and Prof. N.E.M. Jayasekara, Head, Department of Plantation Management for their valuable suggestions and encouragement. Authors would also like to thank Dr. L.C.P. Fernando, Head, Crop Protection Division, Coconut Research Institute, Lunuwila, Sri Lanka, for the provision of required laboratory condition and transport facilities. Special thanks go to Dr. A.A.F.L.K. Perera, Head, Genetic and Plant Breeding Division, for providing the isolated seed garden in Ambakelle to carry out this task successfully. The help given by staff members of the Computer Services Unit of Wayamba University of Sri Lanka, all the staff members of the Crop Protection Division and Genetic and Plant Breeding Division of Coconut Research Institute and the staff at isolated seed garden in Ambakelle is greatly appreciated.

REFERENCES

Fernando, L.C.P., G.J. De Moraes and I.R. Wickramananda, (2000).Proceedings of the International Workshop on Coconut Mite. (*Aceria guerreronis*); 1-8

Keifer, H.H. (1965) Eriophyid studies.B-14.Calif. Dept. Agric. Bureau of Entomol. 20pp.

Liyanage, D.V., M.R.T. Wicramarathne and C. Jayasekara. (1990). Coconut varieties in Sri Lanka. *Cocos Coconut Journal Sri Lanka*: 2-25

Mariu, D. (1977). *Aceria* (Eriophyes) *guerreronis*: un Important revageur des cocotereraies africaines et americaines. Oleagineux **32**:101-111

Muthiah, C. and R. Bhaskaran (1999).Screening of Coconut Genotypes and Management of Eriophyid mite *Aceria guerreronis* (Eriophyidae: Aceri) in Thamilnadu.10 (8) 10-11

Prasad, G.S., and H.R. Ranganath (2000).Occurrence of nut infesting Eriophyid mite *Eriophages guerreronis (k.)* in Coconut plantations in Andaman.

Sathiamma, B., C.P. Radhakrishnan Nair and P.K. Koshy, (1998).Out break of a nut infesting Eriophid mite, *Aceria guerreronis* (k) in coconut plantations in India, *Indian Coconut Journal.* **29** (8):1-3

Siriwardana, P.H.A.P (1999). Development of a new technique to estimate the population of coconut mite *Aceria guerreronis keifer* (Acari: Eriophyidae) in a single nut. Degree of B. Sc. Thesis, University of Paradeniya, Sri Lanka.

Vidyasagar, P.S.P.V. (2000).Eriophyid mite on coconut and their Management, *Indian Coconut Journal* 7:15-16

APPENDIX

Appendix 1. Characters of the three different coconut forms, Sri Lankan Dwarf Yellow, Sri Lankan Dwarf Green and Ambakelle Special.

Characters of the coconut forms	Sri Lankan Dwarf Yellow	Sri Lankan Dwarf Green	Ambakelle Special
1.Height of the palm	Up to 40 ft	Up to 40 ft	Up to 60 ft
2.Size of the trunk	Smaller	Smaller	Larger
3. Root bole	Absent	Absent	Present
4.Length of leaves	Short	Short	Long
5.Start Flowering	From 3-4 years	From 3-4 years	From 6-8 years
6.Pollinaton pattern	Self Pollination	Self Pollination	Cross Pollination
8.Economic lifespan	40 years	40 years	60 years
9.Resistance to Pest and Diseases	low	low	high
10.Adaptation to environmental conditions	Limited adaptation and susceptible to drought	Limited adaptation and susceptible to drought	Wide range of adaptation and tolerant to drought
11.Colour of the nuts	Yellowish	Greenish	Wide range of colours can be observed

Source: Plant Genetics and Breeding Division, CRI, Sri Lanka