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Management of Coconut Mite in Bangladesh Involving Communities as Implanter

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Abstract

A study on management of coconut mite (*Aceria guerreronis* Keifer, Acari: *Eriophyidae*) was carried out in farmers fields at Bagharpara Sub-district of Jashore district, in an area of about 696 ha during May 2011 to June 2014. The mite attacking coconut in Bangladesh remained unidentified until 2008. Field and laboratory studies on morpho-anatomy revealed that 2-6 month old nuts hosted colonies of mites while no mites were found on unfertilized button (flowers) and nuts of more than 06 months old. Colonization was found maximum in younger nuts of 3 -4 month old. Mites were found to reside under the perianth near the stalk of young coconut. Six different treatments viz, removing of infested young nuts and foliar application of Omite @ 0.2% adjacent to the bunch region (T_1); removing of infected young nuts and foliar application of Neem-oil @ 0.3% adjacent to the bunch region (T_2); T_1 & soil incorporation of Neem cake @ 500g/tree (T_3); T_1 & soil incorporation of tricho-compost @ 2000g/tree (T_4); T_2 & soil incorporation of Neem cake @ 500g/tree (T_5) and T_2 & incorporation of tricho-compost 2000g/tree (T_6). Results of three consecutive years showed that all the treatments were equally effective in controlling mite attack in coconut. Edible portion of mature nuts was found to improve by the treatments T_3 and T_5, containing soil incorporated Neem cake. Days to spath opening, male phase, number of bunch and nut per bunch were not influenced by any one of the treatments. On an average 77 nuts were harvested/palm/year and their estimated market value was Taka 1540. Income augmented due to technology was Taka 1339.80 with BCR value 6.

Key words: Aceria guerreronis**,** Bangladesh, Coconut Mite, Neem Cake, Tricho-compost, Omite, Eriophyid.

Introduction

Coconut is considered a subsistence crop in Bangladesh and gives income round the year. It is mainly cultivated in the homesteads with other fruits and vegetables. However, orchard plantation is not uncommon in the off-shore islands and in the seashore in the southern part of the country. In Bangladesh coconut is afflicted frequently with natural calamities and outbreak of anonymous pests and diseases. Coconut mite (*Aceria guerreronis* Keifer) infestation is such a problem in coconut in Bangladesh, which remained unidentified until 2008. It has taken an epidemic turn in south and south-western regions. *A. guerreronis* (Acari: Eryophyidae*)* resides under the bracts (perianth) causing damage to young fruits of coconut (Brian *et al*., 1999; Fernando *et al*., 2002) resulting in small

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sized, deformed fruits and immature nut fall. Due to continuous yield losses many farmers have cut down their coconut palms and shifted to farming other fruit and/or field crops. Since, mite was not recognized at early stage of infestation, exact data on yield loss of coconut are not avaialable in the country. According to FAO STAT (2018), production of coconut in Bangladesh was 89 thousand tons in 2001 which was reduced to 80 thousand tons in 2011. It is suspected mite infestation was one the awful causes of such drop in coconut production in Bangladesh. Islam *et al*. (2008) has found that removal of infested and young nuts up to six months old of mite infested palms and spraying newly developing fruits with "omite" (Abamectin), a sulfite ester group., targeted to prevent further infestation have been proven effective to control coconut mite. They have suggested a large scale investigation in the farmers' fields to confirm the result. Considering the importance of coconut as a potential crop in the county, the present study was undertaken to manage coconut mite through mechanical control by removal of infested fruits followed by application of chemical pesticides and bio-chemicals for prevention of infestation of newly developing nuts.

Materials and Methods

A three year study was carried in an area of about 696 ha in Bagharpara sub-district under the district of Jashore (Longitude, $89^0 06' - 89^0 28'$ and Latitude, $23^0 04' - 23^0 20'$) comprising six consecutive villages. The location of the study was 12 km towards East of the Regional Agricultural Research Station (RARS), a south-western research station of BARI (Figure 1). A pre-prospecting survey was conducted for demarcating the study area and counting the number of palms in the area. A local land-map was used to estimate the area comprising in the study site. Randomized Complete Block Design (RCBD) was adopted and the whole area was divided into three sub-locations as Bloc I, Block II and Block III where treatments were replicated thrice. There were six treatments and each treatment included five (5) palms. Altogether there were 90 (6 x 5 x 3) palms in the

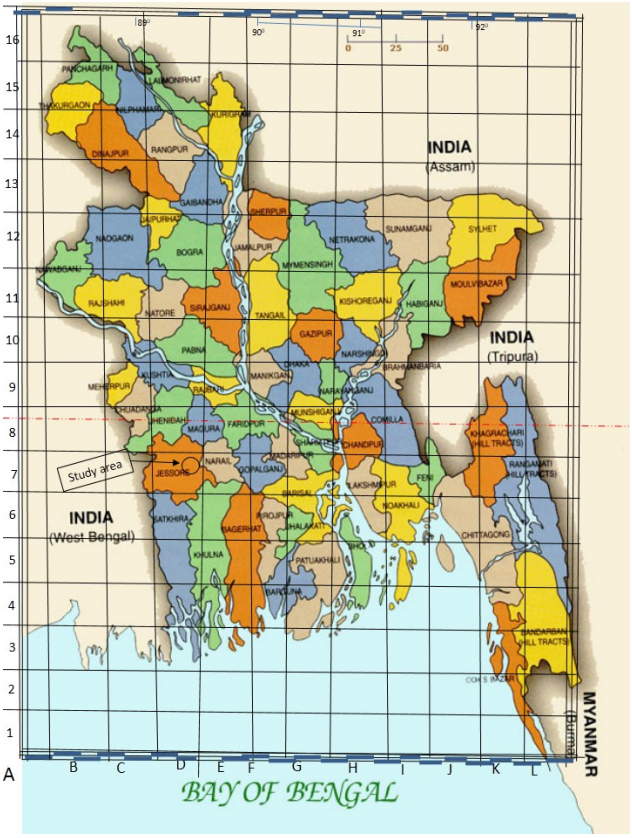

Figure 1. Map of Bangladesh showing location and site of the study of mite management

experimental unit. The treatment combinations were as follows:

T_1: Removing of flowers and foliar application of Omite @ 0.2%

T_2: Removing of flowers and foliar application of Neem oil @ 0.3%

T_3: T_1 & soil incorporation of Neem cake @ 500g/tree

T_4: T_1 & soil incorporation of tricho-compost @ 2000g/tree

T_5: T_2 & soil incorporation of Neem cake @ 500g/tree

T_6: T_2 & incorporation of tricho-compost 2000g/tree

Half of Neem cake and Tricho-compost along with other blanket fertilizer doses were

applied in October 2011. Rest 50% Neem cake as well as Tricho-compost along with other fertilizers were applied in April 2012. Dibbling method of application was used for applying fertilizers. In this method, fertilizers are placed in 4 to 6 inches deep holes, made around the root zones of palm at a distance of 1 meter from the base of the trunk. An iron made dibbler is used to make holes. The frame is pressed into the soil and then dropped in both side to make a hole by hand pressure. The holes are covered with soil after placing fertilizers. The soil around the palms is made moist by watering if needed and rendered weed free before fertilizing. Eight to ten wholes are made around the palm. Six tree-climbers, tow for each sub- location were hired for cleaning and spraying the palms in the study area. Before treating the palms, infected and distorted nuts as well as fruits up to six months old were removed from the palms. Initial numbers of both distorted and healthy nuts (if any) of each palm were recorded as baseline information while cleaning the crown palms for starting applying of treatments. The palms were then treated with six different treatments. Since, the mite of the infested palms re-attack the developing nuts, the palms out sides of the study unit of the area were therefore treated by abamecting (Islam et. al., 2008) to protect new born nuts of the experimental unit. First spray was done in October to November 2011 as soon as after cleaning the crown while the second spray was done in March to April, 2012 when the palms produced fruits and these fruits reached approximately 2-3 months old. Third and fourth sprays were done in two month intervals. Spray of miticide was done adjacent to the bunch area of crown as well as newly born nuts up to six months old. Palms outside the experimental unit were neither fertilized nor treated with Neem cake and Tricho-compost. The study was repeated in 2012-13 and 2013-14 for testing the consistency of the result.

Data recording:

Grading extent of surface damage of nut was done as follows.

i. Grade 0 - nuts with no mite damage

ii. Grade 1 - nuts with 1-29% surface area damage

iii. Grade 2- nuts with 30-59% surface area damage, <20% reduction in size

iv. Grade 3 - nuts with 60-80% surface area damage, 20-30% reduction in size

v. Grade 4- nuts with over 80% surface area damage, over 30% reductions and greatly deformed

At the onset of the study, data on surface damage of nut, number of bunches and nuts per bunch of palm, kernel thickness and weight of nut of all marked palms were recorded as baseline information to compare the treatment effects. After applying treatments, when newly born nuts of palms reached four (4) to five (5) months old, data on surface damage was recorded again. Finally data on surface damage were recorded again when nut age reached around 10 months old.

Data analysis and statistical tools applied:

Average of three years data were used for statistical analysis. Statistical package MSTATC was used to determine ANOVA and Means were separated by DMRT. Means, average, standard deviation, co-efficient of variation (CV %) were estimated by MS Excel to study the nature of data. Simple t-test was performed to compare means of each attributes before and after interventions.

Results and discussion

Information on study area:

The size of the study area was 696 hectares which represents an ecosystem unit and includes around 551 homesteads. Prevailing tropical monsoon climate of the location supports mixed vegetation with various annual and perennial tress including vegetable species. Coconut was a leading plantation species in the homesteads. Traditionally, coconut is grown in the homesteads with other fruits and orchard plantation is hardly found. Total number of coconut palms in the area was counted 4429 with an average of 8 palms per household (Table 1). The data revealed a decreasing trends of number

of palms as compared to that of recent past. Islam et. al., (2010) conducted a survey on production and utilization of coconut in some leading coconut growing areas in Bangladesh during July 2001 to October 2002 and reported 9 to 37 palms per household with an average of 23. Continuous yield loss due to mite attack in coconut and associated low income might cause farmers to cut down their palms and utilizing the land by shifting to cultivating other fruits or field crops (Islam et. al., 2017).

Effect of treatments on surface damage of nuts:

Data on surface damage of nut at early growth stage were recorded in April when nuts ages reached at around five months old while the data on mature stage were recorded in August when nut age reached around nine months old. No surface damage was noticed in nuts of early or mature stages of nuts. It was found that all the treatments was equally effective in controlling damage of nut surface (Table 2; Plates 7-8).

The hypothesis of the study was based on the life cycle of mite and nut growth of palms. Life cycle of coconut mite (CM) is 7-9 days and attacks coconuts immediate after fertilization of buttons (the female flower of coconut) for sucking saps from the growing nuts. Mite sucks nutrients from soft tissues under the perianth of stalk region of growing nuts. Mite cannot suck saps of tissues when nut reaches at age six months and above. So, removing and burning of nuts of palms up to 6 months old to capture and killed mite of the entire ecosystem under study. Virtually, the ecosystem would have mite free until appearing new fruits in the palms. It took around 50 days to come new fruits in the treated palms after the intervention. Spraying of growing nuts by miticide in two months intervals protected from re-attacks of mite. The hypothesis was supported by the findings of Ramarethinam and Loganathan (2000) and Islam et. al., (2008).

Effects of treatments on Phonological events of inflorescence

Days to opening of spathe, male phase, number of bunch and nuts per palms were not influence by the treatments. The edible portion of mature nuts, was found to improve by the treatments T_3 and T_5 which containing soil incorporated Neem cake (Table 2). The results were consistent in all three consecutive years. Neem cake, is a product of Neem seeds, containing trace of oil and other cellular components which acts as repellent of insect pests and give excellent effect on plant growth (Rao, 1991; Palma *et. al;* 2009). In addition insect repellent, after decomposition in rhizosphere and uptake, Neem cake enhance palms to biosynthesize necessary endogenous growth regulators and enzymes for growth and development and which might have encouraged palms to accumulate edible portion of nuts maximum (Palma *et. al;* 2009).

Nut yield

At the onset of the study, average nuts per palm were counted 12, 17 and 18 in three locations. After intervention, yearly nut per palm in average were 119, 118, and 193 respectively (Table 3). Spraying new born nuts with mitides might have protected nuts from re-attack of mite and ensured higher yield of good quality nuts. It is to be noted that 50% of the nuts, harvested before intervention, were marketable and possessed price not more than half of price of normal nuts.

Morpho-anatomical study mite: Morphology of coconut mite was studied under stereo-microscope and documented. Mite colonies were not uniform in the infested nuts. Nuts of 2-6 month old were found to host colonies of mites beneath the perianth of stalk region (Plate 1). No mite was detected in unfertilized button (female flower) as well as in infected nuts of having age six months or above (Plates 2, 3). Button attains receptivity around one month after opening the spathe (Plate 10). Adults, nymphs and eggs were found in each colony (Plate 4). Triangular yellowish brown patches extending distally on the fruit surface from beneath the perianth of developing button indicated the typical symptoms of mite attack (Plate 5). Brown lesions were noticed around the stalk underneath the perianth of infected nuts. (Plate 1). Stalk region under the perianth of a healthy nut is bright white and fresh without any spot (Plate 9).

Table 1: Land area, number of households and coconut palms in the study site

Site	Area	Household	Palms	Number of palms per household
	(ha)	(Nos.)	(Nos.)	(Nos.)
Bolorampur	63	75	393	5
Soyodmahmudpur	190	91	1187	13
Parkul	115	43	278	6
Budhopur	81	52	479	9
Dorajhat	137	166	706	4
Debinagor	110	124	1386	11
Total=	696	551	4429	-
Average=	116	92	738	8

(*Nation yield 21 nuts/palm; source: BBS, 2011)

Table 2. Effects of treatments on Phonology of inflorescence and fruit quality

Treatment	Days to opening of spade	Days to male phase	Bunch/ palm	Nuts/ bunch	Nuts/ palm	Grading on pericarp spot		Edible portion of mature nut (kernel)	Dry matter of kernel at maturity
						6 month after intervention	10 month after intervention		
	(Nos)	(Nos)	(Nos)	(Nos)	(Nos)	(%)	(%)	(%)	(%)
T_1	25.00	27.67	5.33	13	56.33	0	0	17.40 c	33.10
T_2	22.00	27.67	5.33	13	58.67	0	0	15.83 c	31.30
T_3	20.67	26.00	4.67	15	62.00	0	0	24.40 a	37.30
T_4	25.67	25.67	5.00	14	63.67	0	0	16.90 c	36.80
T_5	23.33	25.67	5.00	14	60.00	0	0	21.10 b	38.10
T_6	21.67	24.67	5.00	15	65.67	0	0	17.76 c	40.40
Level of significance	NS	NS	NS	NS	NS			6.65	10.82
CV%	20.06	15.69	6.92	14.78	6.92			**	NS

T_1 : Removing of flowers and foliar application of Omite @ 0.2%;
T_2 : Removing of flowers and foliar application of Neem oil @ 0.3%
T_3 :T_1 & soil incorporation of Neem cake @ 250g/tree
T_4 :T_1 & soil incorporation of tricho-compost @ 1kg/tree
T_5 :T_2 & soil incorporation of Neem cake @ 250g/tree
T_6 :T_2 & incorporation of tricho-compost 1kg/tree

Table 3. Yearly nut set after intervention in palms under experimental unit (average of three years)

Sample palm	Population 1		Population 2		Population 3	
	After intervention	Before treatment	After intervention	Before treatment	After intervention	Before treatment
1	114	28	114	15	147	16
2	115	7	103	18	159	18
3	111	7	113	12	151	18
4	123	12	133	20	150	26
5	115	6	107	17	137	20
6	118	8	103	16	151	15
7	116	14	116	18	133	18
8	211	16	119	18	132	24
9	119	15	129	26	128	17
10	119	11	134	20	133	16
11	117	18	125	15	132	18
12	105	17	117	18	125	16
13	123	14	113	24	143	14
14	113	10	120	17	129	18
15	105	8	118	16	150	14
16	129	11	132	18	150	14
17	120	9	113	16	141	17
18	111	8	123	14	132	19
19	98	11	111	18	139	19
20	98	10	113	14	136	18
21	112	10	133	14	133	19
22	114	9	117	17	97	18
23	116	12	107	19	132	16
24	111	13	119	19	119	14
25	144	12	119	18	142	17
26	124	15	95	19	447	16
27	116	11	110	18	444	18
28	129	17	125	16	450	18
29	117	15	128	14	492	26
30	106	7	116	17	475	20
Average	119	12	118	17	193	18
Standard deviation	19.64	4.50	9.66	2.86	125.59	3.06
CV%	16.51	37.39	8.22	16.46	65.09	17.07
t-stat	55.74		50.98		124.14	
Level of significance	**		**		**	

Table 4. Cost of investment per palm for controlling mite

A. Cost of investment			
Input used (Tk)	Unit price (Taka)	Quantity used	Cost (Taka)
Neem oil cake (Tk)	: 50.00/Kg	=1	50.00
Omite (Tk)	: 140.00/100 ml	=6 ml	9.00
Climbing (Tk)	: 30.00/climbing time	=4	120.00
Sprayer(Tk)	: 240.00/piece	=1/100	11.20
Labor for Neem cake(Tk)	: 300.00/day	=1/300	10.00
B. Income derived by technology (Tk)		Total=	200.20
Number of nut obtained	:77		
Market price/nut (Tk)	:20		
Income obtained (Tk)	:1540		
C. Profit (B-A) (Tk)	:1339.80		
D. Benefit Cost Ratio			
Income before intervention (Tk)	:160		
Income due to intervention (Tk)	: 1339.80		
Income augmented (Tk)	: 1179.80		
BCR	6.00		

Plate 1. Mite infested tender nut of age about 3 month

Plate 2. Unfertilized button nut without any sign of mite attack

Plate 3. Mite infested nut of age about 7 months

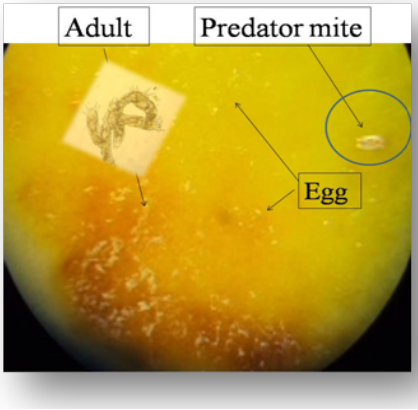

Plate 4. Adult, nymph, egg and predator mite in a colony

Plate 5. Triangular yellowish brown patches extending distally on the fruit surface

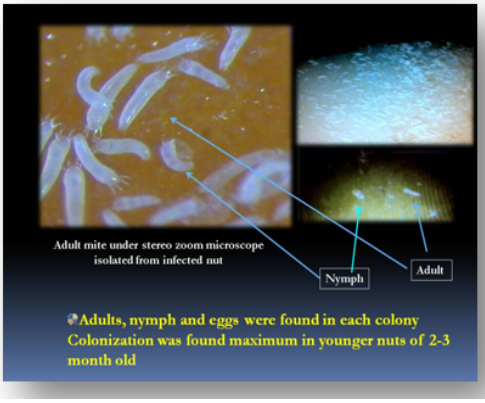

Plate 6. Coconut mite under stereo microscope

Plate 7. Harvesting damage free healthy coconut from a treated palm

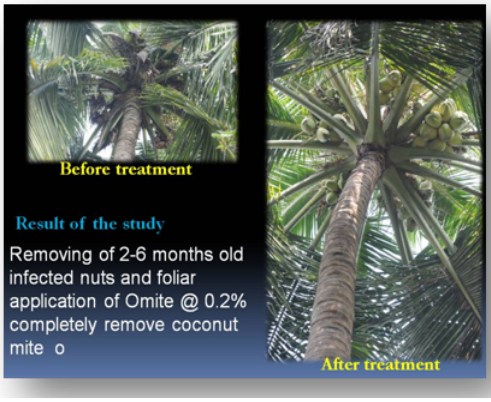

Plate 8. Mite infested palm (a) before treatment (b) after treatment

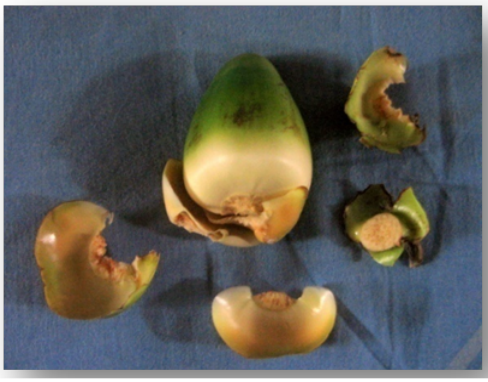

Plate 9. Female flower after fertilization

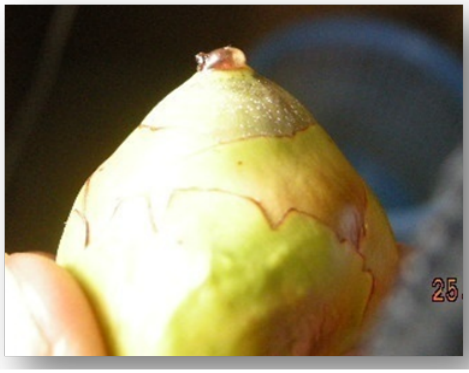

Plate 10. Receptive female flower

Plate 11. Coconut at the extinction due to mite

Plate 12. Infed nuts are cleaning before spraying miticide

The mite was microscopic, slender, vermiform and whitish in color (Plate 6). Eggs were shiny white and globular in shape (Plate 4 & 6). Cardona and Potes (1971), Julia and Mariau (1979) and Hall *et al*., (1980) similarly described and documented mite and infested nut.

Impact of mite attack on harvesting of coconut

Coconut mite was reported for the first time in Bangladesh in early 2004 and it was unidentified until 2008. Exact data on yield loss of coconut due to mite attack not available. According to Bangladesh Bureau of Statistics (BBS) Bangladesh produces yearly 100 million from an area of about 35 thousand hectares in Bangladesh. However, the current study estimates 8 palms per household with an average yield 16 nuts/palm/year (Table 3). Islam et al., (2010) conducted a survey in 23 major coconut growing areas of the country during July 2001-October 2002 and reported 23 palms per household with an average yield 75 nuts per palm per year. It is suspected that mite infestation is one of the major causes of such drop in coconut production in Bangladesh. Similar findings were also report by Islam et. al., (2016) and opined that due to continuous yield loss many farmers removed their palms and shifted to cultivate field crops. At the onset of the intervention, average number of marketable nuts per palm were 16 and their market price was half of the price of normal nut (Table 4).

Economic analysis

Cost of intervention per palm was Taka 200.20. Average nuts per palm were counted 50 to 216 with an average 77, market price of which was estimated Taka 1540 (at the rate of Tk 20/nut). Benefit obtained due to the technology was Taka 1339.80. Before intervention, earning from a palm was estimated 160. Estimated benefit cost ratio (BCR) was 6 (Table 4).

Conclusion and recommendation

The study have shown that infestation of newly developing fruits by coconut mite could be prevented by removal of infested fruits and treating palms with miticides in a large area. The investigation was the beginning of research on coconut mite in Bangladesh condition. For a sustainable recommendation continued investigations are required including chemicals and botanical extracts. The present technology retained the lost yield of coconut. As a result income and employment opportunities from coconut sector might promote more planting of coconut in the country. There is also a beneficiary effect of technology on environment by utilizing atmospheric carbon by coconut for its vegetative growth and fruit production round the year. The present technology may be recommended until a sustainable control measure and management practices against mite are developed.

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