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Cassava leaf harvesting management and positive impact on growth and yields of eri silkworm

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Abstract

Cassava is one of the major host plants for eri silkworm rearing especially in Thailand. The representative for extension and popular varieties, Kasetsart 50 (KU50) and Rayong 11, were experimented in field on effect of cassava leaf harvest management and rearing eri silkworm. Cassava leaves were harvested 3 times (batches) when cassava aged 6, 8 and 10 months. Each time, leaves were harvested 30% of total per plant with 2 methods; harvest every day and every other day. The experiment was conducted using randomized complete block design (RCBD) comprised 4 treatments and 3 replications with 10 plants/replication. It was found that average of Rayong 11 cassava leaves, harvested every other day (68,534.40 leaves/rai) was higher than KU50 (45,758.40 leaves/rai). Also for harvested every day, Rayong 11 (63,883.20 leaves/rai) still had more than KU50 (52,195.20 leaves/rai). The harvested leaves were used as food plant for eri silkworm rearing of 3 batches according to 3 times of leaf harvesting. The life cycle (egg–adult) of all batches fed with KU50 and Rayong 11 were similar (between 41–68 days). Survival of larval stage (1^{st}–5^{th} instar) and larva (1^{st}–5^{th} instar) – adult for the 1^{st} and 2^{nd} batch, Rayong 11 were higher but not significantly different to KU50. Whereas in 3^{rd} batch, KU50 expressed maximum survival percentage of 1^{st}–5^{th} instar (91%) and not significant difference to feeding with Rayong 11 (89.33%). For larva (1^{st}–5^{th} instar) – adult, KU50 still gave the higher survival rate (75%) and significantly different ($P<0.05$) to Rayong 11 (60%). In the case of average of cocoon and egg yields; the 1^{st} batch, all cocoon yields obtained from feeding with KU50 were the highest values. Only fresh cocoon weight, pupa weight, shell weight and total shell weight were significantly different ($P<0.05$) compared to Rayong 11. For egg yields; Rayong 11 exhibited all average yields higher than KU50 and not significant difference. For 2^{nd} batch, all cocoon yields were similar as feeding with both cassava varieties and not significantly different. However, feeding with KU50 derived higher cocoon yields in 3 values; fresh cocoon weight (2.0563 g), pupa weight (1.7650 g) and fresh cocoon weight/10,000 larvae (18.85 kg). While feeding with Rayong 11 gave higher yields of shell weight (0.2830 g), %shell (14.02%) and total shell weight (26.04 g). Moreover, Rayong 11 fed to eri silkworms expressed all higher values with statistical difference ($P<0.05$) on total eggs and total hatchability against feeding with KU50. In 3^{rd} batch, cocoon yields obtained from KU50 were higher only fresh cocoon weight (2.1980 g), pupa weight (1.9156 g) and fresh cocoon weight/10,000 larvae (20 kg). When feeding with Rayong 11 the highest yields were shell weight (0.2870 g), %shell (13.13%) and total shell weight (25.63 g). And egg yields, feeding with KU50 gave all yields higher; total eggs and total hatchability were significantly different ($P<0.05$), compared to feeding with Rayong 11. The results of this research reveal especially method, frequency, timing and variety for cassava leaf harvesting management is very useful in order to gain more benefit for cassava plantation and eri silkworm rearing as a whole.

Keywords: *Cassava, eri silkworm, leaf management, extension variety, rearing*

1. Introduction

Eri silkworm (*Samia ricini* D.) is a wild silkmoth with high withstand, easy to culture and polyvoltine. It is classified as a new industrial insect with national economic value [1 & 2]. Today, the eri silkworm is popular and cultured nationwide in Thailand. This silkworm can be utilized in complete cycle with no waste (zero waste). Such as, the late instar larva and the pupa are a source of safety food and high protein content for human and animals. Cocoon is used to produce eco–textile products and cosmetics. Waste water from the production of silk yarn can be used to make cosmetics and culture microbial insecticide. Feces of the larva are applied as manure, in which containing antagonistic fungi against plant pathogens. The feces and pupa cuticle are able to be applied for plant disease resistance induction. In addition, eri silkworm and pupa can be also added value by cultivation of *Cordyceps* spp [1, 3-5]. Moreover, it also has a great property in feeding various food plants. The main food plants to be fed eri silkworm are castor (*Ricinus communis* L.), kesseru (*Heteropanax fragrans* R.) and cassava (*Manihot esculenta* C.). The castor is a principle food plant and kesseru is an alternative but feeding with comparable to castor and cassava [1, 4 & 6]. In Thailand, castor and cassava are commonly and popularly used as principle food plants for eri silkworm rearing, especially in the Northeast, the largest planting area of cassava. The statistic of cassava production in 2014, cassava planting area of entire the country was about 8,975,865 rai, which planted 4,604,972 rai in the Northeast [7]. Currently, there are different extended cassava varieties planted depending on the specific appropriate areas [8 & 9]. Eri silkworm rearing with cassava leaf is widely studied in Thailand. The leaves from cassava varieties expressed in different yields of eri silkworm. In order to get the effective cultivation of cassava variety, which could be gained more from both cassava tuber and eri silk yield. Besides, the leaf harvest management is included. There was a report indicated that harvesting cassava leaves grown in the Northeast, which 6 month–old (both with fertilizer and without fertilizer) and detached leaf for 30 percent of the total/plant to feed eri silkworm. It resulted the maximum cassava tuber yields, compared to not harvesting leaves from cassava plant [10]. The harvested cassava leaves 3 times (3, 6 and 9 months after planting) gave rise to higher leaf dry weight (dry matter) and protein (crude protein) than harvested 2 times (6 and 9 months after planting) and 1 time (9 months after planting), respectively [11]. Although the cassava is popular for eri silkworm rearing, it often faces with a major outbreak of pests causing the decrease of tubers and leaf yields [12]. Moreover, castor plants lose the leaves upon seasonal, especially in summer. Also, there are negative impacts by diseases and insect pests. According to these obstacles, the food plant will be shortage and insufficient for eri silkworm rearing. Based on the reasons, there is a great need to study on the management of cassava leaf harvesting with suit variety to maximize the productivity of both cassava tuber and eri silk yields. It is an alternative or solution to help cassava growers and eri silkworm farmers.

2. Materials and methods

2.1. Cassava planting

Preparation of experimental field. The experimental soil was coarsely plowed 1 time and fine plowed 1 time. The soil was prepared in the rows with spacing between rows of 100 cm. The soil type is Yasothorn series, sandy loam and dark brown or brownish red color. The field experiment was conducted at Field Crop Experiment Station, Faculty of Agriculture, Khon Kaen University.

Cultural practice Cassava cuttings of 2 varieties {Kasetsart 50 (KU50), Rayong 11} were planted with spacing 100x100 cm. The randomized complete block design (RCBD) was used. Two months after planting, weeding and management were performed according to method of DOA [9].

2.2. Management of cassava leaf harvesting and cassava leaf for eri silkworm rearing

Leaf harvesting management Cassava leaves were harvested 3 times, 1st when 6 month–old, 2nd and 3rd at 8 and 10 month–old after planting. The cassava leaves were counted and harvested only 30%/plant according to Sirimungkarat *et al*. (2000) [10]. The numbers of cassava leaves were compared among non harvest, harvest every day and harvest every other day. Thirty cassava plants (10 plants/replication) of each variety were randomly selected for leaf harvesting.

Methods of leaf harvesting for each variety were as followings. :–

1) The leaves were detached every day (for 9 days) and managed to feed the eri silkworm for 9 days (from 4th instar until the end of 5th instar).
2) The leaves were harvested every other day (5 times in 9 days) and managed to feed the silkworm for 9 days (from 4th instar until the end of 5th instar).

2.3. Eri silkworm rearing with food plant from harvested cassava leaf

Cassava leaves were harvested as described above and started to feed eri silkworms at 4th instar. From 1st – 3rd instar larva, stocks of leaves of each variety from guard rows of experimental field were used as food plant. Eri silkworm rearing was done in rainy season for 1st and 2nd batch (May 26th – July 10th 2014 and August 4th – September 16th 2014) and in cool season for 3rd batch (November 18th 2014 – January 8th 2015). The eri silkworms were fed only 1 time/day according to method of Sirimungkararat *et al.* [10]. The completely randomized design (CRD) was used with 2 treatments and 3 replications. Each replication 100 larvae were reared.

2.4. Data collection

The following parameters were recorded: growth (life cycle, weight and size of 5th instar larva, day 5), survivals {larva (1st – 5th instar and larva (1st – 5th instar) – adult}, cocoon yields directly weigh: {(fresh cocoon weight, pupa weight, shell weight), %shell, total cocoon shell weight and fresh cocoon weight/10,000 larvae}, egg yields (egg/moth, % hatchability, total eggs and total hatchability) including male/female ratio.

3. Results

3.1. Management of cassava leaf harvesting and cassava leaf for eri silkworm rearing

Leaf harvesting management the average numbers of cassava leaf/plant obtained from each batch were not significantly different both from harvest every day and every other day of 2 cassava varieties. Numbers of leaves/plant harvested every day, obtained 3 batches, were nearly values (KU50 had 108.74, Rayong 11 133.09 leaves/plant). For every other day harvesting 3 batches, KU50 had 95.33 leaves/plant and Rayong 11 142.78 leaves/plant (Table 1). The average numbers of leaf/plant of these varieties were converted to total numbers of leaf and total leaf weight per rai (1,600 m^2), including total 30% of total numbers of leaf and total 30% weight of leaves per rai. In comparison to harvesting every day of both varieties for total numbers of leaf and total leaf weight together with total 30% of numbers of leaf and total 30% leaf weight from Rayong 11 and KU50: the Rayong 11 exhibited all values the highest. There were 212,944.00 leaves/rai, 909.27 kg/rai, 63,883.20 leaves/rai and 272.78 kg/rai, respectively, which were not significant difference compared to KU50 except total 30% leaf weight (Table 2). For harvesting leaf every other day, Rayong 11 still expressed higher values of all parameters; total numbers of leaf (228,448.00 leaves/rai), total leaf weight (975.47 kg/rai), total 30% numbers of leaf (68,534.40 leaves/plant) and total 30% leaf weight (292.64 kg/rai). Only average value from Rayong 11 of total numbers of leaf was not significantly different to KU 50 (Table 2).

3.2 The use of harvested leaf for eri silkworm rearing

Life cycle and growth of eri silkworm the life cycles of eri silkworm fed with cassava leaves of KU50 and Rayong 11 harvested from 6 months–old cassava plant (1th batch) were similar. Egg period from eri silkworm fed with KU50 (8–11 days) was a little bit longer than Rayong 11 (8–10 days). Larva stage (1st–5th instar) and pupa stage were the same range of 14–21 days and 17–23 days, respectively. Likewise, the adult periods derived from feeding larvae with KU50 and Rayong 11 were nearly between 4–10 days. In conclusion, egg–adult periods were the same (43–64 days) both rearing with KU50 and Rayong 11 (Table 3). For the 2nd batch (cassava 8 month–old), the range of life cycles were also similar: egg period (8–10 days), adult period (4–12 days) and egg to adult period (41–64 days). Only larva stage (1st–5th instar), 13–20 days) and pupa stage (16–22 days) were in the same range. On the 3rd batch (cassava 10 month–old) the life cycles were the same: egg stage, larva stage (1st–5th instar) and pupa stage. The adult and egg–adult periods were not the same, but they were nearly between 5–12 days and 47–68 days, respectively (Table 3).

For average weight and size of mature larva (5th instar, day 5) of 1st batch (Table 4). Feeding with KU50 expressed the highest weight (6.0624 g), average values of weight (male and female), which was significant difference ($P<0.05$) compared to feeding with Rayong 11 (5.4593 g). In contrast to 1st batch, Rayong 11 in 2nd batch had the highest average larva weight (male and female, 4.8103 g), which was not significant difference to KU50 (4.6674 g). Also, in 3rd batch, Rayong 11 still showed the highest average larva weight of both sexs (5.4940 g) followed by feeding with KU50 (5.0169 g), but not significant difference.

Whereas, the average size of larva body (male and female) (Table 5) of 1st batch fed with both varieties were in the range of 1.0–1.4×7.0–8.8 cm, and KU50 exhibited the highest size (1.3×8.1 cm). For 2nd batch, the average size of male and female body was between 1.0–1.4×6.3–8.3 cm. The bigger size (1.2×7.4 cm) derived from Rayong 11. Also, Rayong 11 in 3rd batch it still gave the average biggest size (1.3×8.0 cm) and average body size of male and female was between 1.1–1.6×6.5–8.7 cm.

Table 1 Yields of cassava leaves/plant obtained from harvest every day and every other day

Cassava variety /treatment	Average numbers of leaf/plant			
	1st Batch	2nd Batch	3rd Batch	Average/3 batch
Kasetsart 50/every day	76.60±12.41 b	94.13±14.67 bc	155.50±15.80	108.74
Kasetsart 50/every other day	65.00±6.33 b	81.00±8.74 c	140.00±15.38	95.33
Rayong 11/every day	117.93±4.04 a	131.80±17.92 ab	149.53±23.34	133.09
Rayong 11/every other day	128.78±23.50 a	136.78±35.03 a	162.78±40.68	142.78
F–test	**	*	ns	
C.V. (%)	14.23	19.35	36.67	

Means followed by the same letter in a column are not significant different (P>0.05, DMRT)
ns = not significantly (P<0.05), * = Significantly different (P<0.05), ** = Significantly different (P<0.01)

Table 2 Yields of cassava leaves/rai harvest every day and every other day

Cassava variety /treatment	Average leaves/rai[2/]		Average 30% harvested leaves/rai[3/]	
	Total numbers of leaf	Total leaf weight[1/](kg)	Total numbers of leaf	Total leaf weight[1/](kg)
Kasetsart 50/every day	173,984.00±66,288.38	595.03±226.71 bc	52,195.20±7,314.96 bc	178.51±34.51 b
Kasetsart 50/every other day	152,528.00±63,201.69	521.65±216.15 c	45,758.40±6,700.81 c	156.49±29.66 b
Rayong 11/every day	212,944.00±25,342.79	909.27±108.21 ab	63,883.20±7,602.84 ab	272.78±30.03 a
Rayong 11/every other day	228,448.00±28,442.22	975.47±121.45 a	68,534.40±8,532.67 a	292.64±36.43 a
F–test	ns	*	*	*
C.V. (%)	25.84	23.52	13.14	19.73

Means followed by the same letter in a column are not significant different (P>0.05, DMRT).
ns = not significantly (P<0.05)
* = Significantly different (P<0.05)
1 Hecter = 6.25 rai, 1 rai contains 1,600 plants
[1/] Calculated from average of fresh leaf of Kasetsart 50 = 3.42 g/leaf and Rayong 11 = 4.27 g/leaf
[2/] Calculated from average number of leaf/plant (3 batches) × 1,600
[3/] Harvested 30% of average number of leaves/rai for 3 batches of eri silkworm rearing

Table 3 Life cycles of eri silkworm (*Samia ricini* D.) fed with cassava leaves harvested from different varieties for 3 batches.

Growth stage	KU 50			Rayong 11		
	1st Batch	2nd Batch	3rd Batch	1st Batch	2nd Batch	3rd Batch
Egg	8–11	8 – 10	10–11	8–10	8 – 9	10–11
Larva (1st–5th instar)	14–21	13 – 20	15–22	14–21	13 – 20	15–22
1st instar	3–4	3–4	4–5	3–4	3–4	4–5
2nd instar	2–3	1–2	2–3	2–3	1–2	2–3
3rd instar	2–3	2–3	2–3	2–3	2–3	2–3
4th instar	2–3	2–3	2–3	2–3	2–3	2–3
5th instar	5–8	5–8	5–8	5–8	5–8	5–8
Pupa	17–23	16–22	17–23	17–23	16–22	17–23
Adult	4–9	5–12	6–12	4–10	4–12	5–12
Female moth	4–9	6–12	6–11	4–10	4–11	5–11
Male moth	4–9	5–12	6–12	4–9	4–12	5–12
Egg–Adult	43–64	42–64	48–68	43–64	41–63	47–68

Table 4 Larva weight of eri silkworm (*Samia ricini* D.) 5th instar (day 5) fed with cassava leaf harvested from different cassava varieties

Batch	Cassava varieties	Average larval weight 5th instar (day 5) (g)		
		Male	Female	Average (male and female)
1st	Kasetsart 50	5.4740±0.19	6.6507±0.18	6.0624±0.18 a
	Rayong 11	4.9811±0.31	5.9375±0.46	5.4593±0.26 b
	F–test	ns	ns	*
	C.V. (%)	4.90	5.53	3.90
2nd	Kasetsart 50	4.4459±0.08	4.8888±0.28	4.6674±0.15
	Rayong 11	2.7280±0.60	6.0764±0.33	4.8103±0.25
	F–test	ns	ns	ns
	C.V. (%)	4.01	5.30	4.27
3rd	Kasetsart 50	4.5632±0.45	5.4706±0.31	5.0169±0.38
	Rayong 11	5.0655±0.19	5.9225±0.13	5.4940±0.15
	F–test	ns	ns	ns
	C.V. (%)	7.16	4.14	5.50

Means followed by the same letter in a column are not significant different (P>0.05, DMRT).
ns = not significantly (P<0.05)
* = Significantly different (P<0.05)

Table 5 Body size of 5th instar (day 5) of eri silkworm (*Samia ricini* D.) fed with cassava leaves harvested from different cassava varieties

Batch	Cassava varieties	Average body size (width × length) (cm)[1/]		
		Male	Female	Average (male and female)
1st	Kasetsart 50	1.1–1.3 x 7.1–8.5 (1.2x7.8)	1.2–1.4 x 7.9–8.7 (1.3x8.4)	1.1–1.4 x 7.1–8.7 (1.3x8.1)
	Rayong 11	1.0–1.3 x 7.1–8.2 (1.2x7.6)	1.1–1.4 x 7–8.8 (1.2x6.6)	1.0–1.4 x 7.1–8.8 (1.2x7.8)
2nd	Kasetsart 50	1.0 – 1.2x6.7 – 7.6 (1.1x7.2)	1.1 –1.3x7.3 – 8.1 (1.1x7.6)	1.0 – 1.3x6.7 – 8.1 (1.1x7.4)
	Rayong 11	1.0 – 1.2x6.3 – 7.8 (1.1x7.1)	1.0 – 1.4x6.4 – 8.3 (1.2x7.7)	1.0 – 1.4x6.3 – 8.3 (1.2x7.4)
3rd	Kasetsart 50	1.1 – 1.2x6.5 – 7.8 (1.1x7.2)	1.2 – 1.6x7.5 – 8.5 (1.3x7.9)	1.1 – 1.6x6.5 – 8.5 (1.2x7.6)
	Rayong 11	1.1–1.3x7.0–8.2 (1.2x7.7)	1.2–1.5x7.9–8.7 (1.3x8.3)	1.1–1.5x7.0–8.7 (1.3x8.0)

[1/] Numbers in parenthesis are average of body size (width × length) of 30 eri silkworms.

Table 6 Survival of eri silkworm (*Samia ricini* D.) fed with harvested leaves from different cassava varieties

Batch	Cassava varieties	Survival (%)	
		Larva (1st–5th instar)	Larva (1st–5th instar) – Adult
1st	Kasetsart 50	92.67±3.51	92.00±4.36
	Rayong 11	93.33±1.53	92.33±1.53
	F–test	ns	ns
	C.V. (%)	2.91	3.54
2nd	Kasetsart 50	91.67±0.58	62.67±14.57
	Rayong 11	92.00±2.00	73.00±13.00
	F–test	ns	ns
	C.V. (%)	1.60	20.36
3rd	Kasetsart 50	91.00±2.65	75.00±6.56 a
	Rayong 11	89.33±4.62	60.00±5.00 b
	F–test	ns	*
	C.V. (%)	4.17	8.64

Means followed by the same letter in a column are not significant different (P>0.05, DMRT).
ns = not significantly (P<0.05)
* = Significantly different (P<0.05)

Table 7 Cocoon yields of eri silkworm (*Samia ricini* D.) fed with harvested leaf management of different cassava varieties

Batch	Cassava varieties	Average yields					
		Fresh cocoon weight (g)	Pupa weight (g)	Shell weight (g)	Shell (%)	Total shell weight (g)	Fresh cocoon weight/10,000 larvae (kg)
1st	Kasetsart 50	2.4345±0.04 a	2.0926±0.04 a	0.3288±0.00 a	13.61±0.40	30.37±1.43 a	22.55±0.50
	Rayong 11	2.3015±0.02 b	1.9935±0.02 b	0.2977±0.00 b	13.00±0.16	27.78±0.51 b	21.48±0.55
	F–test	**	*	**	ns	*	ns
	C.V.(%)	1.41	1.67	1.13	2.32	3.70	2.38
2nd	Kasetsart 50	2.0563±0.08	1.7650±0.07	0.2801±0.01	13.70±0.11	25.68±1.10	18.85±0.79
	Rayong 11	2.0259±0.11	1.7345±0.10	0.2830±0.01	14.02±0.36	26.04±1.38	18.65±1.31
	F–test	ns	ns	ns	ns	ns	ns
	C.V.(%)	4.79	4.89	3.68	1.95	4.82	5.77
3rd	Kasetsart 50	2.1980±0.01	1.9156±0.02	0.2752±0.00	12.60±0.22	25.04±0.52	20.00±0.65
	Rayong 11	2.1872±0.07	1.8896±0.07	0.2870±0.00	13.13±0.43	25.63±1.30	19.56±1.55
	F–test	ns	ns	ns	ns	ns	ns
	C.V.(%)	2.17	2.54	0.79	2.33 (1.13)	3.91	6.02

Means followed by the same letter in a column are not significant different (P>0.05, DMRT).
ns = not significantly (P<0.05)
* = Significantly different (P<0.05)
** = Significantly different (P<0.01)

Table 8 Egg yields of eri silkworm (*Samia ricini* D.) fed with harvested leaf management of different cassava varieties

Bacth	Cassava varieties	Average yields				Male: Female Ratio
		Eggs/ moth	Hatchability (%)	Total eggs	Total hatchability	
1st	Kasetsart 50	388.17±25.87	80.76±1.89	15,709.23±762.90	12,686.87±402.86	1 : 1.16
	Rayong 11	396.50±25.99	83.03±2.22	18,176.23±360.53	15,092.37±331.93	1 : 1.01
	F–test	ns	ns	ns	ns	–
	C.V. (%)	6.62	2.64	12.19	11.34	–
2nd	Kasetsart 50	296.83±51.19	77.26±5.06	7,848.50±164.47 b	6,063.57±325.95 b	1 : 1.21
	Rayong 11	302.80±23.96	78.30±4.79	9,103.23±606.20 a	7,127.47±104.51 a	1 : 1.35
	F–test	ns	ns	*	**	–
	C.V. (%)	13.33	6.25	5.24	3.67	–
3rd	Kasetsart 50	367.27±17.19	83.20±2.94	13,710.83±656.27 a	11,407.70±301.74 a	1 : 1
	Rayong 11	339.32±20.50	73.97±4.21	9,474.21±145.90 b	7,008.05±420.95 b	1 : 1.14
	F–test	ns	ns	**	**	–
	C.V. (%)	6.50	9.10	6.16	9.98	–

Means followed by the same letter in a column are not significant different (P>0.05, DMRT).
ns = not significantly (P<0.05)
* = Significantly different (P<0.05)
** = Significantly different (P<0.01)

Survival of eri silkworm Result obtained the average from eri silkworm rearing 1st batch revealed that the silkworm larva stage (1st–5th instar) and larva (1st–5th instar) – adult} fed with Rayong 11 expressed the highest survival with non–statistic significance to feeding with KU50, which also similar to 2nd batch. However, on 3rd batch, feeding with KU 50 gave the highest survival percentage (91.00%) of larva stage (1st–5th instar) but not significant to Rayong 11 (89.33%). For larva (1st–5th instar)–adult, the survival feeding with KU50 exhibited also the highest survival (75%), which was significant difference to feeding with Rayong 11 (60%) (Table 6).

Eri silkworm yields the average cocoon and egg yields were presented in Table 7 and 8. The cocoon yields (Table 7) obtained from 1st batch expressed clearly that eri silkworm fed with KU50 gave all values the highest; fresh cocoon weight (2.4345 g), pupa weight (2.0926 g), shell weight (0.3288 g), % shell (13.61%), total shell weight (30.37 g) and fresh cocoon weight/10,000 larvae (22.55 kg). Whereas, Rayong 11 yielded lower than KU50, only fresh cocoon weight, pupa weight, shell weight and total shell weight were significant difference ($P<0.05$). For 2nd batch, the yields obtained from 2 cassava varieties were very similar and not significant difference. Only 3 values obtained from KU50; fresh cocoon weight (2.0563 g), pupa weight (1.7650 g) and fresh cocoon weight/10,000 larvae (18.85 kg), were higher than that derived from Rayong 11. The three values from Rayong 11 were higher than from KU50; shell weight (0.2830 g), % shell (14.02%) and total shell weight (26.04 g). And the trend of all cocoon yields derived from 3rd batch was similar to 2nd batch.

For average of egg yields from 1st batch (Table 8), all egg yields derived from Rayong 11 were higher than from KU50, but not significantly different. The sex ratio (male: female) was 1: 1.01–1: 1.16. Result of 2nd batch indicated that all egg yields obtained from feeding with Rayong 11 were still higher than with KU50; eggs/moth (302.80 eggs), % hatchability (78.30%), total eggs (9,103.23 eggs) and total hatchability (7,127.47 eggs). Values: total eggs and total hatchability were significant difference to yields obtained from KU50. The sex ratio of male: female was 1: 1.21–1: 1.35. The yields from 3rd batch fed with KU50 gave rise to all yields higher than Rayong 11; eggs/moth (367.27 eggs), % hatchability (83.20%), total eggs (13,710.83 eggs) and total hatchability (11,407.70 eggs). Only total eggs and total hatchability were statistically significant ($P<0.05$), compared to feed with Rayong 11. In addition, the sex ratio of male: female was 1: 1–1: 1.14.

4. Conclusion and Discussion

4.1. Management of cassava leaf harvesting and cassava leaf for eri silkworm rearing

Leaf harvesting management leaves of KU50 and Rayong 11, the representative extended and popular varieties in Thailand, were harvested 3 times for 30% of total/plant. The harvested leaves were fed 3 batches of eri silkworm. It was shown that the average of Rayong 11 142.78 leaves/plant using every other day harvesting had higher yields than KU50 (95.33 leaves/plant). And, Rayong 11 (133.09 leaves/plant) still provided more leaves than KU50 (108.74 leaves/plant). Thereafter, total numbers of leaf and total leaf weight were converted into per rai, the amount of them from Rayong 11 were still higher when compared with both harvesting methods. Moreover, every other day–leaf harvesting (292.64 kg/rai) of Rayong 11 had more weight than every day–leaf harvesting (272.78 kg/rai). In controversy to KU50, the everyday–leaf harvesting (178.51 kg/rai) was higher than every other day–leaf harvesting (156.49 kg/rai). There was no negative impact on the yield of main host plant of eri silkworm (cassava tuber and castor seed) when 30–40% of leaves were harvested [13]. Presently, no report concerns with leaf harvesting method and special variety for stimulation leaf yields was available. There was only 30% leaf harvesting every day/batch for 3 batches compared between with and without fertilizer in the northeastern region. It revealed that the management starting with 6 month–old cassava (KU50) with and without fertilizer were higher than non management and other management staring cassava with different ages [10]. Of this, it coincides with the report from Attathom *et al.* [14] on cassava Rayong 1. Besides, Phengvichith *et al.* [15] showed that leaf yields were increasing according to the frequency of harvesting in contrast with tuber yields, which was not the same as the above motion result [10] and the positive correlation of 3 times leaf harvesting on leaf and tuber yields in this research with KU50 (forth coming). It should depend on the objective and the technique including the region and test environment.

The use of harvested leaves for eri silkworm rearing. All cultured silkworms (3 batches) with both cassava varieties either every day–harvesting or every other day–harvesting had nearly the same range of life cycle. For survival of larva stage (1st–5th instar) and larva (1st–5th instar) – adult stage of 1st and 2nd batch, Rayong 11 gave the highest but not significant difference. However, KU50 exhibited the 3rd batch more survival than Rayong 11 and significantly different ($P<0.05$). Whereas, the average weight of mature larva (5th instar, day 5), for 1st batch: KU50 was the heaviest (6.0624 g) and significant difference ($P<0.05$) compared to Rayong 11. For 2nd and 3rd batches, it was shown that the larva weight obtained from feeding with Rayong 11 was heavier than KU50 but not statistically different. In addition, KU50 had heavier pupal weight, which is useful as raw material together with larval weight for processing as edible insect [5]. The variable of above results was depended particularly on environment to host plant and finally to the silkworm. Therefore, this effect should be concentrated for gaining high yield. In the case of average cocoon and egg yields, it revealed that: in 1st batch; all the highest cocoon yields were produced by rearing with KU50. Only fresh cocoon weight, pupa weight, shell weight and total shell weight were significantly different ($P<0.05$). In comparison to Rayong 11, for 2nd and 3rd batch, they were similar and not significant difference in all cocoon yields after feeding with these 2 varieties. In over view, the KU50 was suitable variety for cocoon production, especially the first batch. However, for 2nd and 3rd batch the 2 varieties were comparable and not significantly different. Even though, the Rayong 11 variety was still suitable, when concerned in the 2nd and 3rd cocoon yields especially on the economic view of %cocoon shell and total shell weight. Finally, when egg yields were focused, the environment or season could play very important role in this result. For 1st, 2nd and 3rd batch, the durations of raising were in rainy season, rainy season and cool season, respectively. In the rainy season, Rayong 11 was the best while KU50 was better only in cool seasons.

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