Effects of Ten Dietary Management Programs on Performance of Silkworm Hybrids

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Abstract: The purpose of this experiment was to investigation on different delay times in starting of feeding in different instars, and their effects on the performance and uniformity of silkworm larvae. Silkworm egg production stages, egg washing, disinfecting, maintenance of silkworm eggs, microscopic tests in order to removing of contaminated samples against pebrin pathogen, first to fifth larval instars rearing, cocoon production framework and cocoon recording was conducted based on standard guidelines. Ten dietary management programs were used as ten treatments. Performance records analyzed using generalized linear models procedure. All the measured indices was compared between different treatments based completely randomized design model. From obtained results, it has showed that among studied methods, the highest level of best cocoon number belonged to 5th treatment (80.75), and 3rd treatment (44.70) remained at lower level than other methods ($P>0.05$). The highest level of best cocoon weight belonged to 5th treatment (80.75 gr), and 3rd treatment (44.70 gr) remained at lower level than other methods ($P>0.05$). The highest level of larva weight (5th day of 5th instar) belonged to 3rd treatment (3.48 days), and 9th treatment (3.24 days) remained at lower level than other methods ($P<0.05$). Among studied methods, the highest level of female cocoon weight belonged to 1st treatment (2.13 gr), and 2nd treatment (1.90 gr) remained at lower level than other methods ($P<0.05$). The highest female cocoon shell weight belonged to 1st treatment (0.42 gr), and 2nd treatment (0.36 gr) remained at lower level than other methods ($P<0.05$). Among studied methods, the highest level of female cocoon shell percentage belonged to 9th treatment (24.18%), and 2nd treatment (18.94%) remained at lower level than other methods ($P>0.05$). The highest level of male cocoon weight belonged to 6th treatment (1.69 gr), and 2nd treatment (1.56 gr) remained at lower level than other methods ($P<0.05$).

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1. Introduction

Silkworm rearing has huge history in world. Based on the obtained evidences, this activity seems to started and originated from China and has been transferred to other countries. The valuable product of this job natural silk, according to its structural characteristics, despite lower production than other natural and synthetic fibers, causing many cultural, social, and economical exchanges, in the history has provided. Accordingly, addressing the status of this industry can help us to utilize and develop this valuable industry in domestic and foreign relations in the future (Bizhannia and Seidavi, 2004).

Silk formed based on natural protein fibers. These very fine fibers are long and delicate. Yarn length extracted from a cocoon is around 900-1300 meters and it having between 15-20 microns diameter. These fibers have large natural brightness. Silk yarn strength is between 3.6-4.4 gram/denier and have high elasticity capacity. Silk fibers absorb moisture well. The excellent properties of the silk has caused people in different countries from thousands of years ago rearing silkworm an thus a lot of researchers and scientists to study and develop this industry for preparing silk yarn, silk fabrics and silk dyeing economically and scientifically (Seidavi et al., 2006a).

One of the major problems of sericulture and silk cocoon production is the lack of uniformity when rearing silkworm larvae, hence there are small and large larvae simultaneously, and larvae have different instars together. Since there are different nutritional requirements based on larva instars, the incidence of this matter causing larvae cannot supply all their nutritional requirements and hence larvae will be uniform. In addition, since smaller larvae are more sensitive against pathogens, rapid spread of pathogens in the environment will damage large and small larvae (Motahari et al., 2008a; Motahari et al., 2008b; Seidavi et al., 2006b). This set of factors ultimately produced a sharp reduction in the silk production. The purpose of this experiment was to investigation on different delay times in starting of feeding in different instars, and their effects on the performance and uniformity of silkworm larvae.

2. Material and Methods

The experiment was conducted during 2010-2011. The larvae hatched and reared based on ESCAP (1993). Silkworm egg production stages, egg washing, disinfecting, maintenance of silkworm eggs, microscopic tests in order to removing of contaminated samples against pebrin pathogen, first to fifth larval instars rearing, cocoon production framework and cocoon recording was conducted based on standard guidelines and protocols, especially ESCAP (1993). Commercial hybrid silkworm egg was prepared from Iran Silkworm Research Center (ISRC).

Ten treatments were treatment 1 (control): start time of feeding for each of the first to fifth larvae instars were standard and without delay (immediately after larvae molting and readiness for feeding); treatment 2: start time of feeding for each of the first, second and third larvae instars were 24 hours late and delay (24 hours after larvae molting and readiness for feeding) and start time of feeding for each of the fourth and fifth larvae instars were 36 hours late (36 hours after larvae molting and readiness for feeding) in comparison with to the conventional and standard approach; treatment 3: start time of feeding for first larvae instar were 24 hours late and delay (24 hours after larvae molting and readiness for feeding) in comparison with to the conventional and standard approach; treatment 4: start time of feeding for second larvae instar were 24 hours late and delay (24 hours after larvae molting and readiness for feeding) in comparison with to the conventional and standard approach; treatment 5: start time of feeding for third larvae instar were 24 hours late and delay (24 hours after larvae molting and readiness for feeding) in comparison with to the conventional and standard approach; treatment 6: start time of feeding for fourth larvae instar were 36 hours late and delay (36 hours after larvae molting and readiness for feeding) in comparison with to the conventional and standard approach; treatment 7: start time of feeding for fifth larvae instar were 36 hours late and delay (36 hours after larvae molting and readiness for feeding) in comparison with to the conventional and standard approach; treatment 8: start time of feeding for each of the first, second, and third larvae instars were 24 hours late and delay (24 hours after larvae molting and readiness for feeding) in comparison with to the conventional and standard approach; treatment 9: start time of feeding for each of the first, second, and third larvae instars were 12 hours late and delay (12 hours after larvae molting and readiness for feeding) in comparison with to the conventional and standard approach; and treatment 10: start time of feeding for each of the fourth, and fifth larvae instars were 36 hours late and delay (24 hours after larvae molting and readiness for feeding) in comparison with to the conventional and standard approach.

Fifty two studied traits included best cocoon number, best cocoon alive pupae number, best cocoon alive pupae percentage, best cocoon dead pupae number, middle cocoon number, middle cocoon alive pupae number, middle cocoon alive pupae percentage, low cocoon number, low cocoon alive pupae number, low cocoon dead pupae number, double cocoon number, double cocoon alive pupae number, double cocoon alive pupae percentage, double cocoon dead pupae number, cocoon number per one liter, cocoon weight per one liter, best cocoon weight, middle cocoon weight, low cocoon weight, double cocoon weight, 1st larval duration, 1st feeding duration, 1st molting duration, 2nd larval duration, 2nd feeding duration, 2nd molting duration, 3rd larval duration, 3rd feeding duration, 3rd molting duration, 4th larval duration, 4th feeding duration, 4th molting duration, 5th larval duration, 5th feeding duration, mounting duration, young larval duration, grown (mature) larvae duration, larva weight (5th day of 5th instar), 10 larvae weight (5th day of 5th instar), female cocoon weight, female cocoon shell weight, female cocoon shell percentage, coefficient of variations for female cocoon weight, coefficient of variations for female cocoon shell weight, coefficient of variations for female cocoon shell percentage, male cocoon weight, male cocoon shell weight, male cocoon shell percentage, coefficient of variations for male cocoon weight, coefficient of variations for male cocoon shell weight, coefficient of variations for male cocoon shell percentage.

It was used rice straw as cocoon making position (framework) in cocoon spinning stage separately for each replication. After completing of the pupa development (7 days after onset spinning of cocoons), it was collected total produced cocoons. Then, it was sorted and classified all cocoons based on appearance, hardness softness, and cleanliness levels of cortex and outer cortex into four categories including good, moderate, low and double cocoons. Health situation of the cocoon pupae and the disease and mortality of pupae have been studied and it was calculated the percentage of pupa vitality for each replication separately. Also good (male and female) and double cocoon weight in each replication was recorded. All recording steps was performed on the eighth day after the onset of cocoon spinning. Production records analyzed by statistical software SPSS (1999) using generalized linear models procedure (GLM), and after ensuring of data normality, the averages was compared using Tukey test. All the measured indices was compared between different treatments based completely randomized design model (CRD).

3. Results

Obtained results are summarized in Tables 1-9.

Best cocoon number

From obtained results, it has showed that amount of best cocoon number in ten studied methods included between 44.70-80.75. Among studied methods, the highest level of best cocoon number belonged to 5th treatment (80.75), and 3rd treatment (44.70) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Best cocoon alive pupae number

From obtained results, it is showed that amount of best cocoon alive pupae number in ten studied methods included between 71.25-80.25. Among studied methods, the highest level of best cocoon alive pupae number belonged to 5th treatment (80.25), and 1st treatment (71.25) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Best cocoon alive pupae percentage

From obtained results, it is showed that amount of best cocoon alive pupae percentage in ten studied methods included between 95.42-99.40%. Among studied methods, the highest level of best cocoon alive pupae percentage belonged to 5th treatment (99.40%), and 1st treatment (95.42%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P>0.05).

Best cocoon dead pupae number

From obtained results, it is showed that amount of best cocoon dead pupae number in ten studied methods included between 0.50-3.50. Among studied methods, the highest level of best cocoon dead pupae number belonged to 1st treatment (3.50), and 5th treatment (0.50) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Middle cocoon number

From obtained results, it is showed that amount of middle cocoon number in ten studied methods included between 6.25-11.00. Among studied methods, the highest level of middle cocoon number belonged to 6th treatment (11.00), and 3rd treatment (6.25) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Middle cocoon alive pupae number

From obtained results, it is showed that amount of middle cocoon alive pupae number in ten studied methods included between 4.00-10.00. Among studied methods, the highest level of middle cocoon alive pupae number belonged to 6th treatment (10.00), and 3rd treatment (4.00) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Middle cocoon alive pupae percentage

From obtained results, it is showed that amount of middle cocoon alive pupae percentage in ten studied methods included between 65.00-97.50%. Among studied methods, the highest level of middle cocoon alive pupae percentage belonged to 2nd treatment (97.50%), and 3rd treatment (65.00%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Low cocoon number

From obtained results, it is showed that amount of low cocoon number in ten studied methods included between 0.00-1.50. Among studied methods, the highest level of low cocoon number belonged to 4th treatment (1.50), and 1st and 10th treatments (0.00) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Low cocoon alive pupae number

From obtained results, it is showed that amount of low cocoon alive pupae number in ten studied methods included between 0.00-0.50. Among studied methods, the highest level of low cocoon alive pupae number belonged to 6th treatment (0.50), and most of treatments (0.00) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Low cocoon dead pupae number

From obtained results, it is showed that amount of low cocoon dead pupae number in ten studied methods included between 0.00-1.25. Among studied methods, the highest level of low cocoon dead pupae number belonged to 4th treatment (1.25), and 1st and 10th treatment (0.00) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Double cocoon number

From obtained results, it is showed that amount of double cocoon number in ten studied methods included between 0.75-2.50. Among studied methods, the highest level of double cocoon number belonged to 5th and 7th treatments (2.50), and 3rd treatment (0.75) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Double cocoon alive pupae number

From obtained results, it is showed that amount of double cocoon alive pupae number in ten studied methods included between 1.50-4.75. Among studied methods, the highest level of double cocoon alive pupae number belonged to 7th treatments (4.75), and 3rd and 10th treatments (1.50) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Double cocoon alive pupae percentage

From obtained results, it is showed that amount of double cocoon alive pupae percentage in ten studied methods included between 50.00-100.00%. Among studied methods, the highest level of double cocoon alive pupae percentage belonged to 2nd and 10th treatment (100.00%), and 3rd treatment (50.00%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Double cocoon dead pupae number

From obtained results, it is showed that amount of double cocoon dead pupae number in ten studied methods included between 0.00-0.50. Among studied methods, the highest level of double cocoon dead pupae number belonged to some treatments (0.50), and some other treatments (0.00) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Cocoon number per one liter

From obtained results, it is showed that amount of cocoon number per one liter in ten studied methods included between 103.00-123.00. Among studied methods, the highest level of cocoon number per one liter belonged to 7th treatment (123.00), and 3rd treatment (103.00) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Cocoon weight per one liter

From obtained results, it is showed that amount of cocoon weight per one liter in ten studied methods included between 190.64-216.75 gr. Among studied methods, the highest level of cocoon weight per one liter belonged to 9th treatment (216.75 gr), and 3rd treatment (190.64 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Best cocoon weigh

From obtained results, it is showed that amount of best cocoon weight in ten studied methods included between 44.70-80.75 gr. Among studied methods, the highest level of best cocoon weight belonged to 5th treatment (80.75 gr), and 3rd treatment (44.70 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Middle cocoon weight

From obtained results, it is showed that amount of middle cocoon weight in ten studied methods included between 82.57-146.37 gr. Among studied methods, the highest level of middle cocoon weight belonged to 5th treatment (146.37 gr), and 3rd treatment (82.57 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Low cocoon weight

From obtained results, it is showed that amount of low cocoon weight in ten studied methods included between 10.28-18.84 gr. Among studied methods, the highest level of low cocoon weight belonged to 6th treatment (18.84 gr), and 3rd treatment (10.28 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Double cocoon weight

From obtained results, it is showed that amount of double cocoon weight in ten studied methods included between 0.00-2.18 gr. Among studied methods, the highest level of double cocoon weight belonged to 4th treatment (2.18 gr), and 10th treatment (0.00 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

1st larval duration

From obtained results, it is showed that amount of 1st larval duration in ten studied methods included between 4.07-5.08 gr. Among studied methods, the highest level of 1st larval duration belonged to 8th treatment (5.08 gr), and some other treatments (4.07 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

1st feeding duration

From obtained results, it is showed that amount of 1st feeding duration in ten studied methods included between 3.07-3.23 days. Among studied methods, the highest level of 1st feeding duration belonged to 2nd treatment (3.23 days), and 4th treatment (3.07 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

1st molting duration

From obtained results, it is showed that amount of 1st molting duration in ten studied methods included between 1.00-2.00 days. Among studied methods, the highest level of 1st molting duration belonged to 4th treatment (2.00 days), and most of treatments (1.00 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

2nd larval duration

From obtained results, it is showed that amount of 2nd larval duration in ten studied methods included between 2.10-3.05 days. Among studied methods, the highest level of 2nd larval duration belonged to 3rd treatment (3.05 days), and 10th treatment (2.10 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

2nd feeding duration

From obtained results, it is showed that amount of 2nd feeding duration in ten studied methods included between 2.10-3.05 days. Among studied methods, the highest level of 2nd molting duration belonged to 3rd treatment (3.05 days), and 9th treatment (2.10 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

2nd molting duration

From obtained results, it is showed that amount of 2nd molting duration in ten studied methods included between 0.18-2.00 days. Among studied methods, the highest level of 2nd molting duration belonged to 8th treatment (2.00 days), and 4th treatment (0.18 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

3rd larval duration

From obtained results, it is showed that amount of 3rd larval duration in ten studied methods included between 4.01-5.01 days. Among studied methods, the highest level of 3rd larval duration belonged to 2nd treatment (5.01 days), and 8th treatment (4.01 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

3rd feeding duration

From obtained results, it is showed that amount of 3rd feeding duration in ten studied methods included between 3.01-4.01 days. Among studied methods, the highest level of 3rd feeding duration belonged to 4th treatment (4.01 days), and 8th treatment (3.01 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

3rd molting duration

From obtained results, it is showed that amount of 3rd molting duration in ten studied methods included between 44.70-2.00 days. Among studied methods, the highest level of 3rd molting duration belonged to 10th treatment (2.00 days), and 1st treatment (1.00 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

4th larval duration

From obtained results, it is showed that amount of 4th larval duration in ten studied methods included between 5.10-6.17 days. Among studied methods, the highest level of 4th larval duration belonged to 2nd treatment (6.17 days), and 4th treatment (5.10 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

4th feeding duration

From obtained results, it is showed that amount of 4th feeding duration in ten studied methods included between 4.00-4.01 days. Among studied methods, the highest level of 4th feeding duration belonged to most of treatments (4.01 days), and 7th treatment (4.00 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

4th molting duration

From obtained results, it is showed that amount of 4th molting duration in ten studied methods included between 1.09-2.16 days. Among studied methods, the highest level of 4th molting duration belonged to 2nd treatment (2.16 days), and 4th treatment (1.09 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

5th larval duration

From obtained results, it is showed that amount of v in ten studied methods included between 44.70-80.75 days. Among studied methods, the highest level of 5th larval duration belonged to 5th treatment (80.75 days), and 3rd treatment (44.70 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

5th feeding duration

From obtained results, it is showed that amount of 5th feeding duration in ten studied methods included between 7.00-7.23 days. Among studied methods, the highest level of 5th feeding duration belonged to 4th treatment (7.23 days), and 7th treatment (7.00 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Mounting duration

From obtained results, it is showed that amount of mounting duration in ten studied methods included between 0.08-0.21 days. Among studied methods, the highest level of mounting duration belonged to some of treatments (0.21 days), and 1st treatment (0.08 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Young larval duration

From obtained results, it is showed that amount of young larval duration in ten studied methods included between 12.10-15.04 days. Among studied methods, the highest level of young larval duration belonged to 2nd treatment (15.04 days), and 1st treatment (12.10 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant (P>0.05).

Grown (mature) larvae duration

From obtained results, it is showed that amount of grown (mature) larvae duration in ten studied methods included between 12.24-13.23 days. Among studied methods, the highest level of grown (mature) larvae duration belonged to 5th treatment (12.24 days), and some treatments (13.23 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Larva weight (5th day of 5th instar)

From obtained results, it is showed that amount of larva weight (5th day of 5th instar) in ten studied methods included between 3.24-3.48 days. Among studied methods, the highest level of larva weight (5th day of 5th instar) belonged to 3rd treatment (3.48 days), and 9th treatment (3.24 days) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

10 larvae weight (5th day of 5th instar)

From obtained results, it is showed that amount of 10 larvae weight (5th day of 5th instar) in ten studied methods included between 3.24-3.48 gr. Among studied methods, the highest level of larva weight (5th day of 5th instar) belonged to 3rd treatment (3.48 gr), and 9th treatment (3.24 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Female cocoon weight

From obtained results, it is showed that amount of female cocoon weight in ten studied methods included between 1.90-2.13 gr. Among studied methods, the highest level of female cocoon weight belonged to 1st treatment (2.13 gr), and 2nd treatment (1.90 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

Female cocoon shell weight

From obtained results, it is showed that amount of female cocoon shell weight in ten studied methods included between 0.36-0.42 gr. Among studied methods, the highest level of female cocoon shell weight belonged to 1st treatment (0.42 gr), and 2nd treatment (0.36 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant ($P<0.05$).

Female cocoon shell percentage

From obtained results, it is showed that amount of female cocoon shell percentage in ten studied methods included between 18.94-24.18%. Among studied methods, the highest level of female cocoon shell percentage belonged to 9th treatment (24.18%), and 2nd treatment (18.94%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant ($P>0.05$).

Coefficient of variations for female cocoon weight

From obtained results, it is showed that amount of coefficient of variations for female cocoon weight in ten studied methods included between 7.85-11.98%. Among studied methods, the highest level of coefficient of variations for female cocoon weight belonged to 9th treatment (11.98%), and 4th treatment (7.85%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant ($P<0.05$).

Coefficient of variations for female cocoon shell weight

From obtained results, it is showed that amount of coefficient of variations for female cocoon shell weight in ten studied methods included between 8.85-21.22%. Among studied methods, the highest level of coefficient of variations for female cocoon shell weight belonged to 10th treatment (21.22%), and 6th treatment (8.85%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant ($P>0.05$).

Coefficient of variations for female cocoon shell percentage

From obtained results, it is showed that amount of coefficient of variations for female cocoon shell percentage in ten studied methods included between 5.65-60.75%. Among studied methods, the highest level of coefficient of variations for female cocoon shell percentage belonged to 9th treatment (60.75%), and 2nd treatment (5.65%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant ($P>0.05$).

Male cocoon weight

From obtained results, it is showed that amount of male cocoon weight in ten studied methods included between 1.56-1.69 gr. Among studied methods, the highest level of male cocoon weight belonged to 6th treatment (1.69 gr), and 2nd treatment (1.56 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant ($P<0.05$).

Male cocoon shell weight

From obtained results, it is showed that amount of male cocoon shell weight in ten studied methods included between 0.35-0.40 gr. Among studied methods, the highest level of male cocoon shell weight belonged to some treatments (0.40 gr), and 2nd treatment (0.35 gr) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant ($P<0.05$).

Male Cocoon shell percentage

From obtained results, it is showed that amount of male Cocoon shell percentage in ten studied methods included between 22.75-24.41%. Among studied methods, the highest level of male Cocoon shell percentage belonged to 2nd treatment (24.41%), and 7th treatment (22.75%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant ($P>0.05$).

Coefficient of variations for male cocoon weight

From obtained results, it is showed that amount of coefficient of variations for male cocoon weight in ten studied methods included between 7.15-10.29%. Among studied methods, the highest level of coefficient of variations for male cocoon weight belonged to 7th treatment (10.29%), and 2nd treatment (7.15%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were not significant ($P>0.05$).

Table 1- Mean comparison (±SEM) of productive parameters in studied treatments*

Treatment	Parameters					
	Best Cocoon Number	Best Cocoon Alive Pupae Number	Best Cocoon Alive Pupae Percentage, %	Best Cocoon Dead Pupae Number	Middle Cocoon Number	Middle Cocoon Alive Pupae Number
1	74.75±3.30^{a}	71.25±2.59^{a}	95.42±0.95^{b}	3.50±0.87^{a}	9.25±1.55^{a}	7.75±1.44^{ab}
2	76.00±4.60^{a}	74.00±4.10^{a}	97.46±0.77^{ab}	2.00±0.71^{ab}	9.25±1.65^{a}	9.00±1.63^{a}
3	44.75±4.82^{b}	43.50±4.35^{b}	97.41±1.49^{ab}	1.25±0.75^{ab}	6.25±0.48^{a}	4.00±0.71^{b}
4	74.25±3.73^{a}	73.25±4.13^{a}	98.56±0.63^{ab}	1.00±0.41^{ab}	10.75±1.70^{a}	8.75±1.44^{ab}
5	80.75±1.44^{a}	80.25±1.18^{a}	99.40±0.35^{b}	0.50±0.29^{b}	9.50±2.33^{a}	7.75±2.32^{ab}
6	76.50±4.97^{a}	73.75±4.50^{a}	96.51±1.02^{ab}	2.75±0.85^{ab}	11.00±1.73^{a}	10.00±0.82^{ab}
7	78.50±2.40^{a}	75.50±1.94^{a}	96.24±1.16^{ab}	3.00±1.00^{ab}	7.50±0.87^{a}	6.00±0.41^{ab}
8	75.50±2.50^{a}	74.25±2.95^{a}	98.28±0.93^{ab}	1.25±0.63^{ab}	8.25±1.38^{a}	7.50±1.76^{ab}
9	76.00±4.26^{a}	73.50±3.88^{a}	96.77±0.58^{ab}	2.50±0.50^{ab}	8.00±0.58^{a}	7.00±0.41^{ab}
10	70.50±5.17^{a}	68.25±4.73^{a}	97.01±2.20^{ab}	2.25±1.65^{ab}	10.50±3.23^{a}	9.75±3.64^{a}

*Means in each column followed by the same letters are not significantly different at α=0.05

Table 2- Mean comparison (±SEM) of productive parameters in studied treatments*

Treatment	Parameters					
	Middle Cocoon Alive Pupae Percentage, %	Middle Cocoon Dead Pupae Number	Low Cocoon Number	Low Cocoon Alive Pupae Number	Low Cocoon Dead Pupae Number	Double Cocoon Number
1	83.32±4.32^{ab}	1.50±0.50^{a}	0.00±0.00^{b}	0.00±0.00^{a}	0.00±0.00^{a}	1.25±0.47^{a}
2	97.50±2.50^{a}	0.25±0.25^{a}	0.75±0.48^{ab}	0.00±0.00^{a}	0.75±0.48^{a}	1.50±0.28^{a}
3	65.00±2.25^{b}	2.25±0.85^{a}	0.75±0.25^{ab}	0.00±0.00^{a}	0.75±0.25^{a}	0.75±0.47^{a}
4	83.13±8.81^{ab}	2.00±1.08^{a}	1.50±0.65^{a}	0.25±0.25^{a}	1.25±0.48^{a}	1.50±0.50^{a}
5	77.72±13.33^{ab}	1.75±0.75^{a}	1.00±0.41^{ab}	0.00±0.00^{a}	1.00±0.41^{a}	2.50±0.86^{a}
6	93.75±6.25^{ab}	1.00±1.00^{a}	0.75±0.47^{ab}	0.50±0.50^{a}	0.25±0.25^{a}	2.00±1.08^{a}
7	81.79±7.03^{ab}	1.50±0.65^{a}	1.00±0.71^{ab}	0.00±0.00^{a}	1.00±0.71^{a}	2.50±0.50^{a}
8	89.29±10.71^{ab}	0.75±0.75^{a}	0.50±0.50^{ab}	0.00±0.00^{a}	0.50±0.50^{a}	1.75±0.25^{a}
9	88.10±4.60^{ab}	1.00±0.41^{a}	1.25±0.25^{ab}	0.00±0.00^{a}	1.25±0.25^{a}	1.50±0.64^{a}
10	87.50±12.50^{ab}	0.75±0.75^{a}	0.00±0.00^{b}	0.00±0.00^{a}	0.00±0.00^{a}	1.00±0.640^{a}

*Means in each column followed by the same letters are not significantly different at α=0.05

Table 3- Mean comparison (±SEM) of productive parameters in studied treatments*

Treatment	Parameters					
	Double Cocoon Alive Pupae Number	Double Cocoon Alive Pupae Percentage	Double Cocoon Dead Pupae Number	Cocoon Number per one Litr	Cocoon Weight per one Litr	Best Cocoon Weight
	-	%	-	-	gr	gr
1	2.50±0.96^{a}	75.00±25.00^{a}	0.00±0.00^{a}	113.50±1.71^{ab}	211.36±3.86^{a}	142.08±4.88^{a}
2	3.00±0.58^{a}	100.00±0.00^{a}	0.00±0.00^{a}	121.00±2.65^{ab}	205.14±2.82^{a}	129.10±8.52^{a}
3	1.50±0.96^{a}	50.00±8.87^{a}	0.00±0.00^{a}	103.00±4.43^{c}	190.64±8.35^{b}	82.57±9.20^{b}
4	2.50±0.87^{a}	62.50±21.65^{a}	0.50±0.29^{a}	115.50±1.50^{ab}	209.28±2.45^{a}	134.07±5.95^{a}
5	4.50±1.55^{a}	67.71±22.85^{a}	0.50±0.29^{a}	118.25±0.63^{ab}	214.17±2.14^{a}	146.37±1.81^{a}
6	3.75±2.25^{a}	62.50±23.94^{a}	0.25±0.25^{a}	115.50±0.96^{ab}	210.62±3.37^{a}	139.70±8.46^{a}
7	4.75±1.11^{a}	93.75±6.25^{a}	0.25±0.25^{a}	123.00±1.91^{a}	212.79±2.52^{a}	135.81±4.15^{a}
8	3.50±0.50^{a}	100.00±0.00^{a}	0.00±0.00^{a}	117.502.06^{ab}	204.86±3.46^{a}	131.79±4.17^{a}
9	2.75±1.38^{a}	62.50±3.94^{a}	0.25±0.25^{a}	119.50±2.87^{ab}	216.75±4.37^{a}	135.78±6.61^{a}
10	1.50±0.65^{a}	56.25±21.35^{a}	0.50±0.29^{a}	117.50±2.63^{ab}	209.97±4.92^{a}	124.32±8.89^{a}

*Means in each column followed by the same letters are not significantly different at α=0.05

Table 4- Mean comparison (±SEM) of productive parameters in studied treatments*

Treatment	Parameters					
	Middle Cocoon Weight	Low Cocoon Weight	Double Cocoon Weight	1st Larval Duration	1st Feeding Duration	1st Molting Duration
	gr	gr	gr	day	day	day
1	14.85±3.25^{a}	0.00±0.00^{a}	4.74±1.77^{a}	4.08±0.01^{c}	3.08±0.01^{c}	1.00±0.00^{c}
2	13.75±2.56^{a}	1.25±0.79^{a}	5.00±1.10^{a}	5.08±0.00^{a}	3.23±0.00^{a}	1.09±0.00^{b}
3	10.28±0.78^{b}	1.33±0.47^{a}	2.85±1.72^{a}	4.23±0.00^{d}	3.23±0.00^{a}	1.00±0.00^{c}
4	18.40±2.62^{a}	2.18±1.21^{a}	5.54±1.85^{a}	5.07±0.00^{b}	3.07±0.00^{c}	2.00±0.01^{a}
5	15.00±3.78^{a}	2.04±0.86^{a}	9.31±3.20^{a}	4.07±0.00^{e}	3.07±0.00^{c}	1.00±0.00^{c}
6	18.84±2.65^{a}	1.50±0.91^{a}	6.95±3.80^{a}	4.07±0.00^{e}	3.07±0.00^{c}	1.00±0.00^{c}
7	12.49±1.41^{a}	1.69±1.15^{a}	8.91±2.08^{a}	4.07±0.00^{e}	3.07±0.00^{c}	1.00±0.00^{c}
8	13.12±1.90^{a}	0.76±0.76^{a}	6.13±0.91^{a}	5.08±0.00^{a}	3.23±0.00^{a}	1.09±0.00^{b}
9	14.34±1.73^{a}	2.07±0.62^{a}	5.23±2.30^{a}	4.15±0.00^{d}	3.15±0.00^{b}	1.00±0.00^{c}
10	16.70±5.17^{a}	0.00±0.00^{a}	3.54±1.29^{a}	4.07±0.00^{e}	3.07±0.00^{c}	1.00±0.00^{c}

*Means in each column followed by the same letters are not significantly different at α=0.05

Table 5- Mean comparison (±SEM) of productive parameters in studied treatments*

Treatment	Parameters					
	2nd Larval Duration	2nd Feeding Duration	2nd Molting Duration	3rd Larval Duration	3rd Feeding Duration	3rd Molting Duration
	day	day	day	day	day	day
1	3.16±0.01^{c}	2.21±0.01^{c}	0.19±0.00^{d}	4.10±0.01^{bc}	3.10±0.01^{b}	1.00±0.00^{b}
2	5.1±0.01^{a}	3.01±0.01^{b}	2.00±0.01^{a}	5.01±0.01^{a}	3.01±0.01^{c}	2.00±0.01^{a}
3	4.1±0.01^{b}	3.05±0.01^{a}	0.20±0.00^{c}	4.10±0.01^{bc}	3.10±0.01^{b}	1.00±0.00^{b}
4	3.16±0.01^{c}	2.22±0.01^{c}	0.18±0.00^{e}	5.01±0.01^{a}	4.01±0.01^{a}	1.00±0.00^{b}
5	4.16±0.01^{b}	2.21±0.01^{c}	0.19±0.00^{d}	4.10±0.01^{bc}	3.10±0.01^{b}	1.00±0.00^{b}
6	3.91±0.25^{b}	2.21±0.01^{c}	0.19±0.00^{d}	4.35±0.25^{b}	3.10±0.01^{b}	1.25±0.25^{b}
7	3.15±0.00^{c}	2.20±0.00^{c}	0.19±0.00^{d}	4.09±0.00^{c}	3.09±0.00^{b}	1.00±0.00^{b}
8	5.01±0.01^{a}	3.01±0.01^{b}	2.00±0.01^{a}	4.01±0.01^{c}	3.01±0.01^{c}	1.00±0.00^{b}
9	4.01±0.01^{b}	2.10±0.01^{d}	1.15±0.00^{b}	4.10±0.01^{bc}	3.10±0.01^{b}	1.00±0.00^{b}
10	3.16±0.01^{c}	2.21±0.01^{c}	0.19±0.00^{d}	5.10±0.01^{a}	3.10±0.01^{b}	2.00±0.01^{a}

*Means in each column followed by the same letters are not significantly different at α=0.05

Table 6- Mean comparison (±SEM) of productive parameters in studied treatments*

Treatment	Parameters					
	4th Larval Duration	4th Feeding Duration	4th Molting Duration	5th Larval Duration	5th Feeding Duration	Mounting Duration
	day	day	day	day	day	day
1	5.16±0.01^{b}	4.01±0.01^{a}	1.15±0.00^{b}	7.11±0.02^{b}	7.03±0.02^{a}	0.08±0.00^{c}
2	6.17±0.02^{a}	4.01±0.01^{a}	2.16±0.01^{a}	7.02±0.02^{c}	6.11±0.02^{bc}	0.15±0.00^{b}
3	5.16±0.01^{b}	4.01±0.01^{a}	1.15±0.00^{b}	7.08±0.02^{b}	6.11±0.02^{bc}	0.21±0.00^{a}
4	5.10±0.01^{c}	4.01±0.01^{a}	1.09±0.00^{c}	7.23±0.02^{a}	7.02±0.02^{a}	0.21±0.00^{a}
5	5.16±0.01^{b}	4.01±0.01^{a}	1.15±0.00^{b}	7.08±0.02^{b}	6.11±0.02^{bc}	0.21±0.00^{a}
6	5.16±0.01^{a}	4.01±0.01^{a}	1.12±0.04^{bc}	7.08±0.02^{b}	6.34±0.23^{b}	0.18±0.03^{ab}
7	6.15±0.00^{a}	4.00±0.00^{a}	2.15±0.00^{a}	7.00±0.00^{c}	6.09±0.00^{bc}	0.15±0.00^{b}
8	5.16±0.01^{b}	4.01±0.01^{a}	1.15±0.00^{b}	7.08±0.02^{b}	6.11±0.02^{bc}	0.21±0.00^{a}
9	5.16±0.01^{b}	4.01±0.01^{a}	1.15±0.00^{a}	7.11±0.02^{b}	7.03±0.02^{a}	0.08±0.00^{c}
10	6.17±0.02^{a}	4.01±0.01^{a}	2.16±0.01^{b}	7.07±0.02^{b}	6.11±0.02^{bc}	0.20±0.00^{a}

*Means in each column followed by the same letters are not significantly different at α=0.05

Table 7- Mean comparison (±SEM) of productive parameters in studied treatments*

Treatment	Parameters					
	Young Larval Duration	Grown (Mature) Larvae Duration	Larva Weight (5th Day of 5th Instar)	10 Larvae Weight (5th Day of 5th Instar)	Female Cocoon Weight	Female Cocoon Shell Weight
	day	day	gr	gr	gr	gr
1	12.10±0.03^{e}	13.03±0.03^{a}	3.39±0.06^{ab}	3.39±0.06^{ab}	2.13±0.01^{a}	0.42±0.00^{a}
2	15.04±0.04^{a}	13.18±0.03^{a}	3.36±0.06^{ab}	3.36±0.06^{ab}	1.90±0.02^{e}	0.36±0.00^{e}
3	13.11±0.03^{e}	12.24±0.03^{c}	3.48±0.07^{a}	3.48±0.07^{a}	2.07±0.04^{abc}	0.41±0.01^{abc}
4	13.25±0.03^{c}	13.09±0.03^{a}	3.27±0.03	3.27±0.03^{ab}	2.04±0.02^{cde}	0.41±0.00^{abc}
5	13.10±0.03^{d}	12.24±0.03^{c}	3.37±0.14^{ab}	3.37±0.14^{ab}	2.00±0.03^{cde}	0.39±0.00^{cd}
6	13.10±0.03^{d}	12.44±0.19^{b}	3.35±0.04^{ab}	3.35±0.04^{ab}	2.06±0.03^{abc}	0.41±0.00^{c}
7	12.07±0.00^{e}	13.15±0.00^{a}	3.24±0.06^{ab}	3.24±0.06^{ab}	1.97±0.02^{de}	0.39±0.00
8	14.11±0.04^{b}	12.24±0.03^{c}	3.39±0.04^{ab}	3.39±0.04^{ab}	2.00±0.02^{cde}	0.39±0.00^{bcd}
9	13.03±0.03^{d}	13.03±0.03^{a}	3.24±0.08^{ab}	3.24±0.08^{ab}	1.98±0.05^{cde}	0.41±0.01^{abc}
10	13.10±0.03^{e}	13.23±0.03^{a}	3.26±0.11^{ab}	3.26±0.11^{ab}	2.00±0.03^{bcd}	0.40±0.01^{abcd}

*Means in each column followed by the same letters are not significantly different at α=0.05.

Table 8- Mean comparison (±SEM) of productive parameters in studied treatments*

Treatment	Parameters					
	Female Cocoon Shell Percentage	Coefficient of Variations for Female Cocoon Weight	Coefficient of Variations for Female Cocoon Shell Weight	Coefficient of Variations for Female Cocoon Shell Percentage	Male Cocoon Weight	Male Cocoon Shell Weight
	%	%	%	%	gr	gr
1	19.88±0.06^{ab}	9.33±0.88^{ab}	9.88±0.97^{a}	7.60±1.25^{a}	1.68±0.01^{a}	0.40±0.01^{a}
2	18.94±0.09^{ab}	8.97±0.80^{ab}	11.09±0.93^{a}	5.65±0.68^{a}	1.56±0.01^{d}	0.35±0.01^{d}
3	19.93±0.16^{ab}	9.60±0.71^{ab}	10.32±0.79^{a}	7.79±0.46^{a}	1.60±0.01^{cd}	0.38±0.02^{bc}
4	20.11±0.10^{ab}	7.85±0.71^{b}	8.29±0.18^{a}	6.32±0.28^{a}	1.67±0.02^{ab}	0.40±0.01^{ab}
5	19.70±0.10^{ab}	11.92±0.83^{a}	13.09±0.36^{a}	9.34±0.90^{a}	1.61±0.04^{bc}	0.37±0.02^{cd}
6	19.91±0.12^{ab}	8.42±0.67^{ab}	8.85±0.89^{a}	6.88±0.42^{a}	1.69±0.02^{a}	0.40±0.01^{ab}
7	19.87±0.17^{ab}	9.07±0.72^{ab}	10.47±1.02^{a}	7.62±0.79^{a}	1.57±0.02^{de}	0.38±0.01^{c}
8	19.75±0.16^{ab}	8.37±0.77^{ab}	10.09±0.83^{a}	8.50±1.19^{a}	1.59±0.03^{cd}	0.37±0.01^{cd}
9	24.18±4.17^{a}	11.98±2.83^{a}	17.61±8.24^{a}	60.75±54.62^{a}	1.63±0.03^{abc}	0.38±0.02^{bc}
10	20.31±0.62^{ab}	10.04±0.72^{ab}	21.22±9.67^{a}	18.89±9.52^{a}	1.58±0.02^{de}	0.38±0.01^{bc}

*Means in each column followed by the same letters are not significantly different at α=0.05

Table 9- Mean comparison (±SEM) of productive parameters in studied treatments*

Treatment	Parameters			
	Male Cocoon Shell Percentage	Coefficient of Variations for Male Cocoon Weight	Coefficient of Variations for Male Cocoon Shell Weight	Coefficient of Variations for Male Cocoon Shell Percentage
	%	%	%	%
1	23.93±0.23[ab]	10.09±1.16[a]	12.76±1.46[abc]	9.68±1.16[ab]
2	22.75±0.18[d]	7.15±0.56[a]	9.38±1.60[cd]	6.65±1.20[b]
3	23.94±0.30 [ab]	10.34±0.76[a]	14.72±2.03[a]	10.64±3.29[ab]
4	23.78±0.19[abc]	7.08±0.87[a]	9.16±0.70[ab]	8.00±0.51[ab]
5	22.98±0.42[cd]	10.06±1.28[a]	13.26±0.98[ab]	10.14±1.31[ab]
6	23.61±0.27[abcd]	7.59±0.74[a]	8.31±0.55[d]	7.89±0.59[ab]
7	24.41±0.54[a]	10.29±1.98[a]	11.21±0.27[abcd]	17.30±8.52[a]
8	23.31±0.22[bcd]	8.07±0.16[a]	11.63±0.37[abcd]	9.21±0.81[ab]
9	23.61±0.15[abcd]	9.29±1.40[a]	10.32±0.60[bcd]	9.14±0.98[ab]
10	24.10±0.16 [ab]	7.76±0.97[a]	9.70±1.17[bcd]	8.02±1.44[ab]

*Means in each column followed by the same letters are not significantly different at α=0.05

Coefficient of variations for male cocoon shell weight

From obtained results, it is showed that amount of coefficient of variations for male cocoon shell weight in ten studied methods included between 8.31-14.72%. Among studied methods, the highest level of coefficient of variations for male cocoon shell weight belonged to 3rd treatment (14.72%), and 6th treatment (8.31%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P>0.05).

Coefficient of variations for male cocoon shell percentage

From obtained results, it is showed that amount of coefficient of variations for male cocoon shell percentage in ten studied methods included between 6.65-17.30%. Among studied methods, the highest level of coefficient of variations for male cocoon shell percentage belonged to 7th treatment (17.30%), and 2nd treatment (6.65%) remained at lower level than other methods. Other methods were between these two groups. Meanwhile statistical differences between studied methods for this trait were significant (P<0.05).

4. Discussion

Starting of silkworm feeding after hatching or after molting at different instars, depending on breed and environment temperature is different. According to studies done by the researchers, larvae just about 41 minutes after hatch are starting to feeding. In the second instar, larvae are feeding 99 minutes after molting. This delay increase as instars increases, so larvae at the fifth instar are eating 167 minutes after the molting. Feeding start time is depended and based on different factors such as larvae garlic or hungry, environmental conditions, larval appetite etc. Silkworm has little mobility after feeding and keeps up its head and chest, and is pale and drawn its body and skin. Their skin is loose after digestion of mulberry consumption and larvae starts to crawl which is a sign as hungry.

Resistance is a quantitative trait with incessant distribution and affected by major genes and minor genes. It was demonstrated that silkworm resistance controlled by double dominance gene on un-sexual chromosomes. If there is random mates in successive generations of silkworm population, natural selection resulted to major genes and modifier genes.

To date various studies has been conducted on nutrition pattern and hunger tolerance levels of various insects (Simpson, 1981; Simpson, 1982; Simpson, 1983; Simpson, 1995; Simpson and Abisgold, 1985; Simpson and Ludlow, 1986; Simpson and Raubenheimer, 1993; Reynolds et al, 1986; Barton and Raubenheimer, 2003; Bernays and Singer, 1998; Bernays and Woods, 2000; Cohen et al, 1988;) but so far very few reports have been published regarding silkworm feeding patterns (Hamamura, 1959, Hamamura et al, 1962; Ueda and Suzuki, 1967; Hirao et al, 1976; Hirao et al, 1978; Hirao and Yamaoka, 1981).

Sericulture is a labor intensive industry with its agricultural part of mulberry cultivation, silkworm egg production and silkworm rearing as well as its industrial sector of cocoon processing, silk reeling and weaving. The silkworm rearing is a traditional industry in Asia and the life of many people is depended on it. Hence improvement of rearing management can increase its income and attraction among farmers. Defining future scenarios for agricultural production and deriving management programs of feeding improvement for these scenarios is a useful tool in developing rearing strategies that are robust to changes in markets. Therefore, it is necessary to study the effect of other constraints of production system on various rearing methods of important traits in silkworm hybrids.

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